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Thinking Otherwise

Somewhere on the higher slopes of Mount Parnassus a small, dark grey car makes its way along a roughly tarmacked track. The road is fringed with snow; far below, the Gulf of Corinth glitters in the sun. The car moves slowly, almost carefully: it is watching the road. It has eyes – several of them – which track the edges of the embankments, identify the white markings at the junctions, note and transcribe where stops are made and turnings taken. It has other senses too: it can tell how fast it is travelling, where it is on the map, what angle the steering wheel is set to. And it has a kind of mind. Not a very sophisticated one, but with a clear focus and a capacity to learn from its surroundings, integrate its findings, and extrapolate and make predictions about the world around it. That mind was perched precariously on the passenger seat; I sat at the wheel, still in control, for now.

All this took place a few years ago, in the winter of 2017, when I decided to try and build myself a self-driving car. And although it never – quite – drove itself, it did take me to some pretty interesting places.

The idea of a self-driving car is fascinating to me. Not really for its capabilities, but for its place in our imagination. The self-driving car is one of those technologies which in the space of just a few years has gone from space-age, 'Life in the Twenty-First Century' fantasy to humdrum reality, without ever passing through a period of critical reflection or assimilation. In moments like this, reality is rewritten. The same will almost certainly be true of more advanced forms of AI. They will appear, suddenly, in our midst – the long slog of research and development, invisible to most, forgotten in the fact of their reality. Questions about who gets to do that rewriting of reality, which decisions are made along the way, and who gains from it, are all too often missed and forgotten in the excitement. That is why I believe that it's crucially important for as many of us as possible to be engaged in thinking through the implications of new technologies; and that this process has to include learning about and tinkering with the things ourselves.

My attempt at building an autonomous vehicle consisted of a rented SEAT hatchback, a few cheap webcams, a smartphone taped to the steering wheel, and some software copied and pasted from the internet.[1] This wasn't a case of programming a dumb machine with everything it needed to know in advance, however. Like the commercial systems developed by Google, Tesla and others, my car would learn to drive by watching *me* drive: by comparing the view from the cameras with my speed, acceleration, steering wheel position and so forth, the system matched my behaviour with the road shape and condition, and after a couple of weeks it had learned how to keep a vehicle on the road – in a simulator at least. I'm not the world's best driver, and I wouldn't trust anyone's life to this thing, but the experience of writing code and going out on the road gave me a better understanding of how certain kinds of AI operate, and what it feels like to work alongside a learning system.

I wondered too what it would mean to do this kind of work far from the highways of California, where Silicon Valley trains its self-driving cars, or the test-tracks of Bavaria, where the giants of the automotive industry evolve new models, and instead on the roads of Greece, where I had recently found myself living. This was a place with a very different material and mythological past and present. It turned out to go beautifully.

Leaving Athens and heading north with no particular destination in mind, other than to give my AI co-pilot a taste of many different kinds of terrain, I soon found myself passing the ancient sites of Thebes and Marathon, and climbing towards the dark bulk of Mount Parnassus. In Greek mythology, Parnassus was sacred to the cult of the god Dionysus, whose ecstatic mysteries were revealed by consuming copious amounts of wine and dancing wildly; participants in such rites liberated the beast within to become one with nature. Parnassus was also the home of the Muses, the goddesses who inspired literature, science

and the arts. To attain the summit of Parnassus is thus to be elevated to the peak of knowledge, craft and skill.

Chance and geography conspired to frame a fascinating question. What would it mean, mythologically speaking, to be driven up Parnassus by an AI? On the one hand, it might be read as a kind of submission to the machine: an admission that the human race has run its course, and that it is time to pass the mantle of exploration and discovery to our robot overlords. On the other hand, to attempt the journey in the spirit of mutual understanding rather than conquest might just be how we write a new narrative onto Parnassus – one in which human and machine intelligences amplify, rather than try to outdo, one another.

I started this project because I wanted to understand AI better, and in particular because I wanted to have the experience of collaborating with an intelligent machine, rather than trying to determine its output. In fact, the whole effort was predicated on a kind of anti-determinacy: I wanted to plan as little as possible about the whole journey. So one thing I did, when training the car, was to drive completely at random, taking almost every side road and turning I came across, wandering and wondering, and getting totally, happily lost. In turn, by watching me, the car learned to get lost too.

This was a deliberate rejection of the kind of driving most of us do today: plugging a destination into a GPS system and following its directions without question or input. This loss of agency and control is mirrored in society at large. Confronted by ever more complex and opaque technologies, we capitulate to their commands, and a combination of fear and boredom is the frequent result. Instead of surrendering to a set of processes I didn't understand, only to arrive at a pre-selected location, I wanted to go on an adventure with the technology, to collaborate with it in the production of new and unforeseen outcomes.

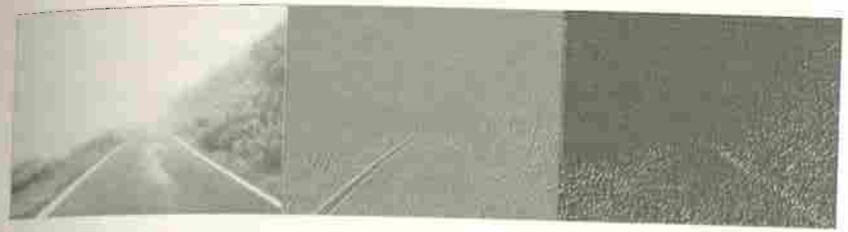
In this, my approach owed more to the *flâneur* than the engineer. The *flâneur* or *flâneuse* of nineteenth-century Paris was a person who walked the streets without a care in the world, an urban explorer on whom the impressions of the city would play and play out. In the twentieth century, the figure of the *flâneur* was picked up by proponents of the *dérive*, or drift: a way of combating the malaise and boredom of modern life through unplanned walks, attentiveness to one's surroundings and encounters with unexpected events. The twentieth-century philosopher Guy Debord, the primary theorist of the *dérive*, always insisted that such walks were best undertaken in company, so that people's differing impressions of the group could resonate with and amplify one another. In the twenty-first century, could my autonomous companion perform the same role?[2]

As well as getting lost, I was trying to think of ways to illustrate what I was coming to think of as the *umwelt* of my self-driving car. Coined by the early twentieth-century German biologist Jakob von Uexküll, *umwelt* literally translates as 'environment' or 'surroundings' – but, being German, it means a lot more than that. The *umwelt* connotes the particular perspective of a particular organism: its internal model of the world, composed of its knowledge and perceptions. The *umwelt* of the tick parasite, for example, consists of just three incredibly specialized facts or factors: the odour of butyric acid, which indicates the presence of an animal to feed upon; the temperature of 37 degrees Celsius, which indicates the presence of warm blood; and the hairiness of mammals, which it navigates to find its sustenance. From these three qualities, the tick's whole universe blooms.[3]

Crucially, an organism creates its own *umwelt*, but also continually reshapes it in its encounter with the world. In this way, the concept of *umwelt* asserts both the individuality of every organism and the inseparability of its mind from the world. Everything is unique *and* entangled. Of course, in a more-than-human world, it's not only organisms which have an *umwelt* – everything does.

The *umwelt* has long been a useful concept in robotics as well as biology. It's easy to see how the example of the tick's simple rules could be adapted to provide the basic framework for a simple, autonomous robot: 'move towards this light; stop at that sound; react to this input.' What then is the *umwelt* of the self-driving car?

The simple intelligence at the heart of my car is called a neural network, one of the most common forms of learning machine in use today. It is a programme designed to simulate a series of artificial 'neurons', or smaller processing units, arranged in layers like an extremely simplified brain. Input signals – the speed of the car, the position of the steering wheel, the view from the cameras – are fed into these neurons, sliced into component parts, compared, contrasted, analysed and



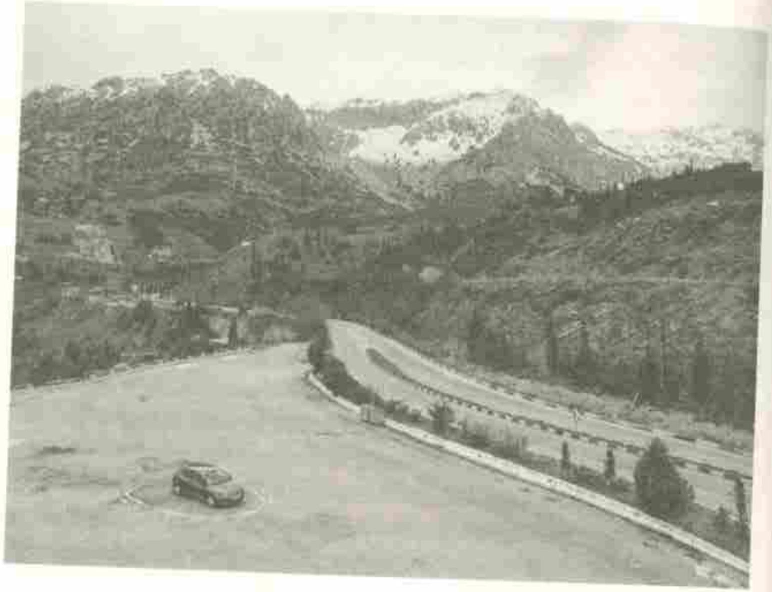
Visualizations of a neural network's way of seeing.

associated. As this data flows through the layers of neurons, this analysis becomes ever more detailed and ever more abstract – and therefore harder for an outsider to understand. But we can visualize aspects of this data. In particular, once the car has been trained a little, we can see what the network thinks is important about what it sees.[4]

The images above illustrate a little of that. The first is the view directly from the car's main camera: a road in Parnassus, disappearing into the mist. The second is how that image looks when it has passed through two layers of the network; the third is the fourth layer. Of course, these are visualizations for human eyes: the machine 'sees' only a representation in data. But these images are data too: the details which remain in the image are the details which the machine thinks are important about the image. In this case, the important details are the lines along the side of the road. The machine has decided from its observations that these lines are of some importance; as indeed they are, if the machine is to stay on the road. Like the tick's sensitivity to the temperature of mammalian blood, the lines on the road form an important part of the car's *umwelt*.

And in this observation, we find the point where my *umwelt* is entangled with that of the car. I see the lines too. We share at least one aspect of our models of the world – and from this, too, whole universes might bloom.

To dramatize this revelation of a shared model – and therefore a shared world – I did something which felt a little mean. As much as I'd grown into our collaboration, and fond of my automated companion, I decided to test it. And so, using several kilo bags of salt, I poured out onto the ground a solid circle a few metres in diameter, and then around it I drew a dashed circle. Together, these circles formed a



Autonomous Trap 001, Mount Parnassus, 2017.

closed space in which the (European) road marking for 'No Entry' is projected inwards. As a result, any well-trained, law-abiding autonomous vehicle, on entering the circle, would find itself unable to leave it. I called it the Autonomous Trap.

This crude attack on the machine's sense of the world was intended to make a few points. The first is political: by working with these technologies, we can learn something of their world, and this knowledge can be used to turn them to more interesting and equitable ends – or to stop them in their tracks. Faced with the kind of corporate intelligences we encountered in the Introduction, this is useful knowledge.

Secondly, it asserts that the tools of the imagination and aesthetic representation are as important in an age of machines as they ever were. Art has a role to play here, and we can intervene in the development and application of technology as effectively from this position as from that of an engineer or programmer. This is useful knowledge too.

Mostly, though, I wanted to emphasize the aspects of the world

which the AI and ourselves perceive in common: our shared *umwelt*. My video of the Autonomous Trap subsequently went viral, and I have the feeling that people appreciated the chutzpah and the whiff of black magic more than the collaboration: in an age of Uber, air pollution, mass automation and corporate AI, there's something pleasing about stopping the robot in its tracks. Nevertheless, the fact remains: we share a world with our creations.

If seeing the relationships between humans and artificial intelligences as creative collaborations rather than open competitions produces such interesting results, what else might be possible? What other intelligences share worlds, and what is to be found in their encounters and imbrications? If contemporary ideas about artificial intelligence seem to be leading us down a darkly corporate, extractive and damaging path, what alternatives exist?

The current, dominant form of artificial intelligence, the kind you hear everyone talking about, is not creative or collaborative or imaginative. It is either totally subservient – frankly, stupid – or it is oppositional, aggressive and dangerous (and possibly still stupid). It is pattern analysis, image description, facial recognition and traffic management; it is oil prospecting, financial arbitrage, autonomous weapons systems, and chess programmes that utterly destroy human opposition. Corporate tasks, corporate profits, corporate intelligence.

In this, corporate AI does have one commonality with the natural world – or rather, with our false, historical conception of it. It imagines an environment red in tooth and claw, in which naked and frail humanity must battle with devastating forces and subdue them, bending them to his will (and it is usually his) in the form of agriculture, architecture, animal husbandry and domestication. This way of seeing the world has produced a three-tiered classification system for the kinds of animals we encounter: pets, livestock and wild beasts, each with their own attributes and attitudes. In transferring this analogy to the world of AI, it seems evident that thus far we have mostly created domesticated machines of the first kind, we have begun to corral a feedlot of the second, and we live in fear of unleashing the third.

Where does my self-driving car sit in this taxonomy? It's mostly 'pet' – a domesticated machine under my control – but it's also productive, in harness, a working animal; and, because of my insistence that it goes where it pleases, it's a little wild, a little unpredictable. With careless handling, the self-driving car might be considered among the most damaging applications of AI. Not only does it contribute directly to the destruction of the planet through material extraction and carbon emissions – at least, until we get fully solar, sustainable versions – but it also steals from us the very real, if guilty, pleasure of driving.

Only those who have already lost most of their joy could consider this an improvement on the current situation. But considered differently, autonomous transport could replace the kinds of selfish, individual transportation we rely upon at present, and reinvigorate public transport, shared ownership and environmentally appropriate usage. It might also return us to the world, by making us more aware of our surroundings and our fellow travellers. In this way it could liberate us from the mundanity of everyday life, and introduce us to a host of chattering new companions, starting with itself. That it is capable of such different outcomes, depending on how we approach it, tells us that those historical categories of animal and machine – of master, servant, slave and resource – are not to be trusted. Indeed, we should scrap them altogether: for the machines, and for everyone else.

It seems to me significant that just as we start to question the real meaning of 'artificial' intelligence, science is starting to explore what it means to call something or someone intelligent across the board. Our myths and fables have always held a place for the liveliness of non-human beings – and non-Western cultures, with deeper knowledge and longer memories, have always insisted on their agency – but for Western science, they have always been tricky territory. On the one hand, we've always known animals were *smart*, in the most stunning diversity of ways, but official discourse has always held off from ascribing them *intelligence*.

It's at this point that we have to ask, well, what do we mean by intelligence? This is not only the most crucial question we could ask, but also the most diverting, and ultimately the most shattering and generative – because, honestly, nobody really knows.

There are many different qualities which we categorize as intelligent. They include, but are far from limited to, the capacity for logic,

comprehension, self-awareness, learning, emotional understanding, creativity, reasoning, problem-solving and planning. There are many reductive versions of this list: attempts to show how one capacity is really the product of another, or accounts which claim that one is more important than the others. But, historically, the most significant definition of intelligence is *what humans do*. No other definition, however elegantly phrased or extensively researched, has a chance of standing up to this one. When we speak about advanced artificial intelligence, or 'general' artificial intelligence, this is what we mean. An intelligence which operates at the same level, and in much the same manner, as human intelligence.

This error infects all our reckonings with artificial intelligence. For example, despite never being used by serious AI researchers, the Turing Test remains the most widely understood way of thinking about the capabilities of AI in the public consciousness. It was proposed by Alan Turing in a 1950 paper, 'Computing Machinery and Intelligence'. Turing thought that instead of questioning whether computers were truly intelligent, we could at least establish that they appeared intelligent. Turing called his method for doing this 'the imitation game': he imagined a set-up in which an interviewer interrogated two hidden interlocutors – one human, one machine – and tried to tell which was which. A machine was intelligent, according to this test, if it could successfully pass itself off as human in conversation. It is testament to our solipsistic way of thinking that this is still what we consider to be a benchmark for general artificial intelligence today.[5]

In fairness to Turing, his idea was a bit more complicated than that. He was less concerned with whether a machine could be intelligent than with whether we could imagine an intelligent machine – a crucial difference, and one which was of more use to his own thinking about how computers might develop. In his 1950 paper, he considered nine objections to the idea of general machine intelligence, all of which are still current today. These included the religious objection (machines have no soul, so cannot think); mathematical objections (per Gödel's incompleteness theorems, no logical system can answer all possible questions); and physiological objections (the brain is not digital, but continuous, and true intelligence must share this quality).

Turing provided counter-arguments to each of these objections many of which have also proved prescient. One of the most famous objections was posited by the very first computer programmer, Ada Lovelace, when she was working on Charles Babbage's early computer design, the Analytical Engine, in the middle of the nineteenth century. Lovelace wrote that the Engine 'has no pretensions to originate anything. It can do whatever we know how to order it to perform.' Computers only do what you tell them to do, thus they can never be described as intelligent.

But Turing disagreed with Lovelace. He believed that, as technology progressed, it would be possible to design circuitry which could adapt itself to new inputs and thus new behaviours – a kind of 'conditioned reflex', similar to that of animals, leading to 'learning'. He understood why Babbage and Lovelace hadn't thought this likely, but by the middle of twentieth century it seemed quite possible: today, Turing's prediction has indeed been realized. The machine-learning algorithms at work in everything from my self-driving car to chess machines, YouTube recommendations and online fraud protection, are examples of exactly the kind of machines that Lovelace said could not exist. (The argument concerning the immortal soul, on the other hand, is somewhat harder to adjudicate.)

Turing also profoundly disagreed with Lovelace's view that 'a machine can never take us by surprise'. On the contrary, Turing wrote, 'Machines take me by surprise with great frequency', usually because he had misunderstood their function, or calculated something wrongly. In such cases, he wondered, was the surprise 'due to some creative mental act on my part' – or did it 'reflect credit on the machine'? Turing felt that this objection was a dead end as it led back to the question of consciousness – but he felt moved to emphasize that 'the appreciation of something as surprising requires as much of a "creative mental act" whether the surprising event originates from a man, a book, a machine or anything else.'

In Turing's argument, I hear more than a mere acknowledgement of the possibility of machine intelligence. First, his appreciation of it is also a recognition that human intelligence is not all that great. Turing describes his own thinking as 'hurried, slipshod fashion, taking risks', and it is this self-awareness that makes the machine's behaviour so surprising. Here we find an intimation, at the very founding of the

discipline of artificial intelligence, that machine intelligence is somehow different from human intelligence. Secondly, in placing his emphasis on the 'creative mental act' of interpreting the machine's response, Turing touches upon something very interesting: the idea that perhaps intelligence doesn't reside wholly inside the head or the machine, but somewhere in between – in the relationship between them.

We have always tended to think of intelligence as being 'what humans do' and also 'what happens inside our head'. But in this early sketch of intelligent machines, Turing suggests something else: that intelligence might be multiple and relational: that it might take many different forms, and that it might exist between, rather than within, beings of all and diverse kinds.

The ongoing popularity of the Turing Test for artificial intelligence, a process which is deeply human-centric and individualized, shows that these kind of nuanced ideas about intelligence did not gain much traction. Instead, we continue to judge AI and other beings by our own standards. This wilful blindness is now being dramatized in our confusion regarding the role and possibilities for artificial intelligence, but it might also allow us to see more clearly how our thinking about other beings has been clouded. In rethinking 'artificial' intelligence, we might begin to rethink intelligence across the board.

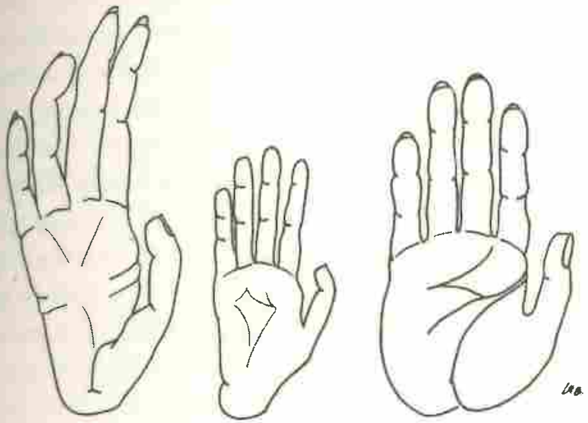
The same arguments that Turing rejected still hamper our ability to recognize all kinds of non-human intelligence, even when it's staring us right in the face. Or, as we shall see, staring itself in the face. Or hitting us with a stick. Or singing, or dancing, or making art, or making plans, or making culture. *No*, we say, time and time again. *Not like that. Like this*. The lengths we go to in our attempts to prove or disprove to ourselves that other beings are worthy of being called intelligent might be absurd if they weren't so tragic. The experimental record provides a shining and faultless account, not of the lack or otherwise of intelligence in others, but of a lack of awareness on our own part.

One of the ways we like to evaluate the intelligence of other animals is by getting them to solve puzzles and, in more 'advanced' animals, to test their ability to use tools to do so. A classic test of this kind is to place some tempting food just out of reach and give an animal a tool for obtaining it, like a stick or a piece of string. If they manage it, they've demonstrated the ability to recognize a problem, think it through, make plans and carry them out, and manipulate tools – all classic signs of intelligence. We've been playing this game for years with apes and monkeys, and most of them are pretty good at it: chimpanzees, gorillas, humans, orang-utans, and all kinds of smaller monkeys will quickly make use of any implements they're provided with to snare the treat.

But another primate, the gibbon, refused point blank to play along. For years, gibbons presented a conundrum, because despite belonging to the same class of large-brained apes as chimpanzees and humans, they would ignore the stick and fail to obtain the food; thus rendering them, according to scientific categorization, less intelligent. What was more, gibbons showed the same attitude in many kinds of tests: they refused to pick up cups as part of a response test, and disdained to investigate upturned containers in search of treats.

One researcher, writing in 1932 about a white-handed gibbon named Charlotte, did concede that 'conceivably these errors may have been caused by lack of interest and motivation rather than by any intellectual deficiency, as our animal, although perfectly tame and tractable, evinced frequently a total indifference to the entire experimental situation.' Given the tasks required and the conditions under which most experimental animals were kept – and many still are – this seems, frankly, fair enough. The same researchers recorded their surprise that baboons, despite being 'primitive' and 'dog-like', did far better at the tests they were set. The researchers concluded, against all of their instincts and their understanding of evolution, that baboons were superior in intelligence to gibbons. But they were ultimately proved wrong. The fault lay not with the gibbon, but with us.[6]

In 1967, four gibbons – their names unknown – took part in an experiment at the Chicago Zoo and showed us what we'd been missing. In previous tests, food had been attached to strings lying on the ground. Tugging on the strings would have brought the food into the animals' enclosure, but the gibbons had ignored them. In the 1967 experiment, the researchers hung the strings from the roof of the enclosure: immediately the gibbons grasped them, tugged, and got



PHOTOGRAPH 1

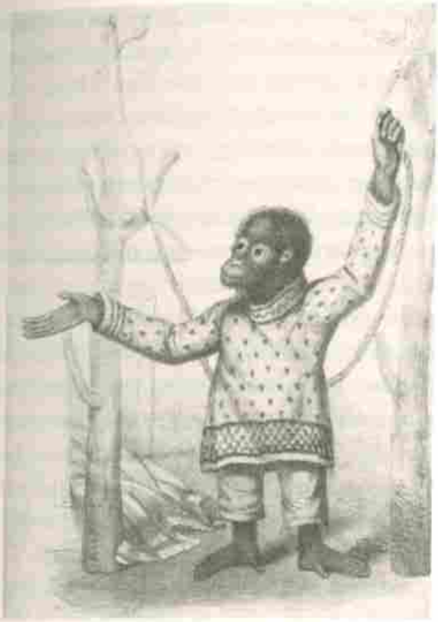
The gibbon hand and fingers are greatly elongated relative to the macaque and man. As a result it is more difficult for the gibbon to pick up objects lying on a flat surface.

Illustration from Benjamin B. Beck, 'A Study of Problem Solving by Gibbons', 1967.

their snacks. In one swift motion, the gibbons suddenly became 'intelligent' – according, that is, to the narrow definition of the scientific method.[7]

The 1967 experiment was designed to account for the fact that gibbons are brachiators. In their natural forest habitat, they spend almost all their time in the trees, and move around by swinging from branch to branch. This results in physiological – as well as, it seems, cognitive – differences to other apes (including us). To make climbing and swinging easier, gibbons have elongated fingers. While an excellent adaptation for an arboreal lifestyle, this makes it harder for them to pick up objects lying on flat surfaces. It also, some researchers believe, makes them less likely to notice such things: their attention and interest, and therefore their problem-solving and planning, points upwards. They notice and make use of tools when they're where (and what) they expect tools to be. Put another way, the gibbon's *umwelt* is arboreal – and if we don't account for that in our own models, we're likely to miss out on what makes them smart.

Embodied as we are, with a different body pattern and pattern of



Portrait of Jenny, the first orang-utan at London Zoo.

orang-utan, also named Jenny. She described this Jenny's appearance as 'frightful and painfully and disagreeably human', which I imagine is what she thought about a lot of actual people.)

Darwin was allowed to enter Jenny's enclosure in the Giraffe House, which had additional heating installed for her comfort. He later wrote to his sister about his impressions:

> The keeper showed her an apple, but would not give it her, whereupon she threw herself on her back, kicked & cried, precisely like a naughty child. She then looked very sulky & after two or three fits of pashion [sic], the keeper said, 'Jenny if you will stop bawling & be a good girl, I will give you the apple.' She certainly understood every word of his, &, though like a child, she had great work to stop whining, she at last succeeded, & then got the apple, with which she jumped into an armchair & began eating it, with the most contented countenance imaginable.

ıd only recently returned from his voyage aboard HMS ıs another twenty years before he would publish *On the ecies*, and another ten before he would explicitly include is theory of evolution, in *The Descent of Man*, in 1871. was already thinking, and writing in secret, about the etween men and apes. He returned twice to the zoo in subths, bringing Jenny small gifts each time – a mouth organ, nint, a sprig of verbena – and each time he was astonished ses. 'Let man visit Ouranoutang in domestication . . . see its . . and then let him boast of his proud preeminence,' he notebook. 'Man in his arrogance thinks himself a great the interposition of a deity. More humble and I believe ler him created from animals.' With these words, Darwin ıowledge that his own recognition of non-human intelliındational to his development of evolutionary theory: a lusion, given the many subsequent ways his theory has to justify human superiority.

ır, Darwin's attention had been drawn to how Jenny elf in the mirror. Did she recognize herself, and if so, what ecognition signify? More than a century later, Gordon a psychologist at Tulane University, wondered the same)arwin's, Gallup's musings weren't sparked by an encounımal, but rather with himself in the mirror while shaving. d to me,' he recalled later, 'wouldn't it be interesting to atures could recognize themselves in mirrors?'[10]

Tulane, Gallup had access to a number of chimpanzees born free in Africa and shipped to the US for bioch. Being captured, rather than born in captivity, they d to be less exposed to human behaviour and customs ve'll see later, this is assuming a lot about what consbehaviour)

look at the inside of their mouths, to make faces at the mirror, to inspect their genitals, to remove mucous from the corner of their eyes,' he recalled.

In order to record this change in behaviour scientifically, Gallup devised an experiment. After a week of exposure to the mirror, the chimps were anaesthetized and a smooth, odourless dot of dye was applied to the top of one eyebrow, and to the opposite ear. When they awoke, they were again shown the mirror, and their responses closely observed.

The results were obvious: immediately upon seeing themselves reflected, the chimps started touching and poking the marked areas, and sniffing and tasting their fingers. 'Insofar as self-recognition of one's mirror image implies a concept of self,' wrote Gallup in the subsequent paper, 'these data would seem to qualify as the first experimental demonstration of a self-concept in a subhuman form.'[11] The term 'subhuman' should give us pause to consider the presumptions of the writer, although its use was not unusual for the time. Gallup did not record the names of the chimpanzee participants, if they had been given any. Nevertheless, 'It was just clear as day,' he later recalled. 'It didn't require any statistics. There it was. Bingo.'

The mirror test soon became the standard test for self-awareness, and over the years many different species have been subjected to it. Humans generally pass the mirror test at around eighteen months – with some important exceptions we'll get to shortly – and this evidence of self-awareness is regarded as a key milestone in childhood development. But like many such cognitive tests, its main effect is to reinforce the sense of a dividing line between 'higher' and other animals, rather than to suggest any sense of shared kinship: we decide who 'passes' the test, and can thus claim the elevated state of subjecthood, and who does not. As within human society, we'd rather extend the in-group candidates, and indeed they exhibit clear responses to mirrors: blowing bubbles and inspecting their bodies carefully, as well as responding to marks. But magpies have been shown to exhibit reflective behaviour, as have ants: these behaviours might have as much to do with social relations, or different senses, as they do with vision.[12]

The responses of these animals differ from those of apes in other ways too. Psychologists Diana Reiss and Lori Marino – former students of Gallup – started exposing dolphins to mirrors at Marine World in California in the 1990s. The dolphins responded immediately: by having sex with each other in front of the mirrors. The researchers referred to these recordings privately as 'dolphin porno tapes' and in the literature as 'suggestive' of self-awareness. It was another decade before they figured out how to mark dolphins in such a way that they could better categorize their responses. As soon as they did this, dolphin self-awareness was immediately clear: the dolphins pirouetted and flipped upside down to view markings on their heads and backs which would otherwise be invisible to them.[13]

Effective as it may seem, there are some issues with the mirror test. The first obvious problem, as with the gibbon's arboreal *umwelt*, is that bodies matter to minds. The way we perceive and act in the world is shaped by the limbs, senses and contexts we possess and inhabit. My favourite example of this is, again, elephants. We think elephants should pass the test, because they seem so smart in many other ways, but for years they failed to respond in any discernible way to the presence of marks on their faces. A much-cited 1989 study of Shanthi and Ambika, two elephants at the National Zoological Park in Washington DC, is entitled 'Failure to Find Self-Recognition in Asian Elephants (Elephas maximus) in Contrast to Their Use of Mirror Cues to Discover Hidden Food'.[14] It highlights the fact that while the pair were able to use mirrors to solve puzzles (because they reliably reached for treats visible only in the mirror – a separate and complex motor task which many apes fail), they ignored marks placed on their bodies, and thereby failed to demonstrate self-awareness in the scientists' definition of the term.

Others saw a problem with the study. In the original experiment, the mirror was placed on the ground, outside the elephants' enclosure, meaning that what the elephant saw was mostly legs and bars – hardly

ideal conditions for self-recognition. Working with three Asian elephants at the Bronx Zoo named Patty, Maxine and Happy, researchers Joshua Plotnik and Diana Reiss (the same Diana Reiss from the dolphin study) found that at least one of the pachyderms was quite capable of self-recognition – provided the mirror was big enough and close enough. They installed an eight-foot mirror inside the elephants' enclosure and found it immediately attracted attention, with the elephants rubbing themselves against it, swinging their trunks over the wall, and attempting to get behind it – possibly to see where the other elephant was. But after a little while, like the chimps before them, they became accustomed to it, and when Happy was marked with a large white cross above her right eye, she immediately started touching it repeatedly. In this way, the Asian elephant joined the self-recognition club – as with the gibbons, a case, it seems, of humans finally being smart enough to figure out where they were being dumb before.[15]

That's the position of the renowned animal behaviourist Frans de Waal, who cites the case of Happy in his book *Are We Smart Enough To Know How Smart Animals Are?* (Plotnik was one of his students, and de Waal is a co-author on the paper.) De Waal notes that some other Asian elephants in Thailand have passed the test too – but many have also 'failed' it. (For the record, the originator of the test, Gordon Gallup, disputed the results for elephants and dolphins (and presumably magpies, ants and other critters) because he believed self-awareness is unique to 'higher' primates.) Meanwhile, one of de Waal's star students, Daniel Povinelli, author of the first elephant paper, argues that the mirror test tells us nothing at all about inner states, only about the ability to match movements to an image. The mirror test, across all species, remains deeply contested today.

The best example, for me, of animal physiognomy causing issues with the mirror test also involves elephants. Patty, Maxine, Happy and the Thai elephants are all Asian elephants, and the experiments suggest they possess mirror test self-awareness. Their larger and more rambunctious African cousins have yet to do so, but this doesn't of course mean they don't possess it. Rather, no researcher has yet built a mirror big and strong enough to withstand the trunk, tusks and natural inquisitiveness of these 10,000-pound pachyderms. In every such test so far, the elephants have ended up destroying the mirrors.

One perspective not included in these discussions is any real recognition of the elephants as individuals. Digging into the history of such experiments, we find that the story of Happy is not a happy one. She was captured in the wild in 1971, together with six other young elephants, and brought to the US from Thailand. The calves were sold for $800 each to a safari park in California, where they were named after the seven dwarves from *Snow White*. For more than forty years, Happy lived at the Bronx Zoo, which in 2014 was ranked the fifth worst zoo for elephants in the US by the international animal protection organization In Defense of Animals.[16] Until 2002, she shared an enclosure with Grumpy, another of the Thai captives, but when the pair were introduced to Patty and Maxine, Maxine attacked Grumpy, who died shortly afterwards from his injuries. The effect of these events on the elephants' differing responses to the mirror test is not recorded – nor is it routinely a part of such studies. Individual animals are taken as synecdoches for the whole species, and while it takes many such studies to draw firm conclusions, an individual's personal history (the kernel of selfhood, the *umwelt*, remember, is the creation of the individual) is not taken into account.

We can, however, see how the countenance and behaviour of these animals differed. Videos accompanying the study are available on the website of the Proceedings of the National Academy of Sciences. They show a bare, concrete, dirt-floored enclosure; they also show clear contrasts in the elephants' behaviours. Patty and Maxine violently attack the mirror when it's first installed; Happy keeps her distance. Patty and Maxine are tested together, but Happy appears by herself. Since the death of Grumpy's replacement, Sammie, in 2006, Happy has lived alone.

'Happy spends most of her time indoors in a large holding facility lined with elephant cages, which are about twice the length of the animals' bodies,' reported the *New York Post* in 2012. 'The public never sees this.' The mirror test depends on differentiating the self from another individual; how much different must it feel to an elephant accustomed to solitude, who has suffered trauma and loss inflicted by other elephants? Whatever the innate intelligence of a species, we must surely acknowledge that the quality of it, and the capacity for its demonstration, is unique to every individual.[17]

Happy in her enclosure at the Bronx Zoo, 2012.

Unlike comparative cognition studies, the law treats subjects as individuals – at least when applied to humans. But Happy is also the subject of a ground-breaking legal case brought by the Nonhuman Rights Project, an animal advocacy organization based in Florida. Since 2018, the NhRP has been seeking Happy's release to a dedicated animal sanctuary under a writ of habeas corpus, the medieval legal doctrine which protects against unlawful detention or imprisonment. Historically, habeas corpus has only applied to humans, but the NhRP is seeking to change this: they have also filed writs on behalf of a number of gorillas and chimpanzees. None have so far been successful, and Happy's case is still in progress. We'll explore the deeper implications of this approach in a later chapter, but it seems significant that the NhRP's case treats Happy as an individual, with a unique history, needs and set of experiences, all of which are ignored in most scientific research into the intelligence, being and personhood of animals.[18]

Here's another potential problem with the mirror test: maybe the kind of self-scrutiny which humans are accustomed to performing just isn't that important to other animals? In the original dolphin study, one hypothesis suggested that dolphins wouldn't pass the mirror test because dolphins don't groom themselves. Indeed, sex rather than self-care seemed to be their priority. But it also seems as if many animals that 'fail' the mirror test nonetheless exhibit plenty of interest in their own reflection – more than enough to make it clear they know it's 'them' in the mirror. For many of these animals, it seems that the act of touching a mark on the face has more to do with social cues than cognitive ones.

To illustrate this possibility, let's return to our old friend the gibbon, who, when presented with a mirror, will ignore any such marks, instead continuing to treat their own reflection as if it were another gibbon: making social gestures, and trying to reach around the mirror to touch the perceived 'other'. In one comprehensive Australian test, a total of seventeen gibbons were tested. (The cohort was actually twenty, but 'three could not be tested as they refused to approach the experimenter' – and fair enough.) Their names were Philip, Kayak, Arjuna, Jury, Jars, Ulysses, Mang, Suli, Irian, Jaya, Ronnie, Bradley, May, Siam, Sydney, Milton and Milo. They were given treats of icing cream to spur their interest, but they steadfastly ignored icing-like dots painted on their eyebrows.[19] This 'evidence of absence' was presumed by the scientists to support a phylogenetic account of self-recognition – that is, the idea that this ability emerged at a particular point in the evolution of apes, some time between 18 and 14 million years ago, after gibbons split from the line that led to modern humans (and before the split that led to orang-utans). Of course, this doesn't account for the possibility of convergent evolution – the emergence of a similar trait along different evolutionary lines – which might account for the ability in elephants, magpies, orcas and dolphins – but more on that later. Let's stick to apes for now.

Perhaps the answer, as I suggested, is that faces just aren't that important to some species, or are bound up with other cues that are less significant to humans and other higher apes. Rhesus macaques are small, lively monkeys: well known in many cities across Asia for their tendency to live closely among humans. I remember watching them steal food from market stalls in India – and being terrified as they chased visitors out of temple grounds, where large sticks were provided to defend against them. Less fortunately for the macaques, the similarity of their immune system, as well as certain neurological

structures, to that of humans makes them popular subjects for medical experiments. It was in the context of such an experiment that the rhesus's ability to self-recognize became evident.

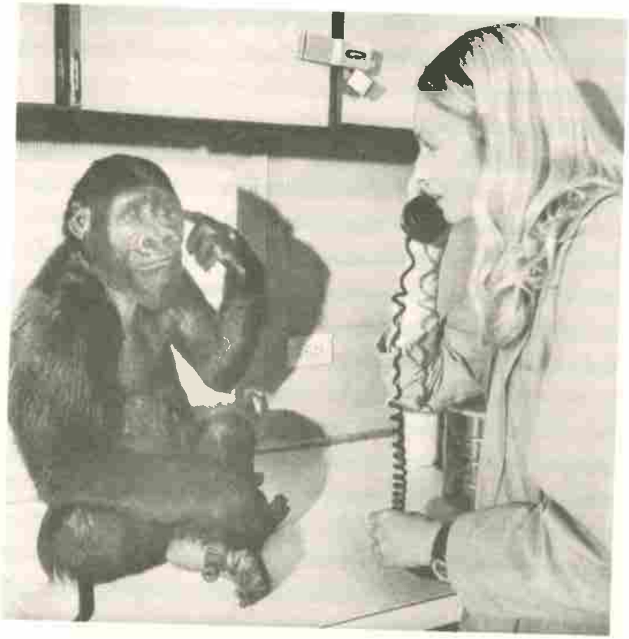
At the University of Wisconsin-Madison, two macaques were prepared for a neurological experiment. The experiment required screwing an inch-square block of blue acrylic to the top of their skulls, with attachments for electrodes and restraints. (This study, unlike many of those cited above, did not name the macaque participants – and in images and video accompanying the paper 'the view of the head implant has been blocked for discretion'.)[20] The researchers quickly noticed that the macaques behaved in a markedly different way to any others in the literature. While macaques typically investigate and display in front of the mirrors, they nonetheless steadfastly avoid eye contact with their reflections, or treat them as they would rivals. The implanted macaques, in contrast, spent considerable time examining the tops of their heads – as I'm sure any of us would if someone bolted a block of blue plastic onto it. And once they'd started doing that in the mirror, they started looking at and grooming other parts of themselves, mostly their genitals.

So, does this make macaques self-aware after all? Eye contact is bound up with hierarchy, dominance and aggression in ways that make staring at a stranger highly uncomfortable. One explanation for the macaques' behaviour is that because they are so socially aware, they really don't like looking at each other. This would explain their continued – but intermittent – social behaviour in front of the mirror, which is never concentrated enough for them to pass through this stage and realize they're looking at themselves – as happened in time with the chimps and other higher apes. In the case of the implanted macaques, it took a powerful counter-stimulus – having a block of plastic screwed to their heads – to make it to the next level.

Faces might just not be that important at all in the thinking of other species, or at least have very different significance, and so approaches like the mirror test, which reproduce humans' own obsession with faces reflected in the mirror, are simply inappropriate. Macaque monkeys, who demonstrate smartness in so many ways, might just not think that being face-to-face matters. On the other hand, they do masturbate a lot and look at each others' butts. Most scientific still conclude that macaques lack self-awareness, but I don't buy it. Of course these animals are self-aware: it's just that if you tend to communicate by showing your butt to someone rather than your face, that's what you're going to check out in the mirror. Macaque Instagram would contain a lot of butt selfies.

As with Happy the elephant, there are many species in which only one individual has passed the mirror test, or in which the circumstances for passing the test vary widely. Species and individual differences matter, and attending to those differences allows us to see how our own perspectives cloud our judgement, and impair our ability to recognize the abilities of others.

Despite all the theory about higher and lower apes, most gorillas (considered 'higher' apes) fail the mirror test. Like macaques, gorillas have a strong aversion to eye contact, considering it a threat, so they don't like looking at faces in the mirror. While there's plenty of



Koko the gorilla learning sign language with trainer Penny Patterson, 3 March 1978.

evidence – such as grooming and exploring hidden areas of their bodies in mirrors – that they 'see' themselves, ever more ingenious tests, such as angling mirrors and hiding food, have found no widespread, scientific evidence for self-recognition (that is, touching facial marks).[21] This might seem like a species-specific problem. In fact, it's more of an individual one. To understand the significance of this, let's look at the story of Koko.

Koko was a female gorilla who lived for forty-six years in captivity – forty-five of which were under the care of animal psychologist Francine Patterson at the Gorilla Foundation in Woodside, California. Patterson taught Koko more than a thousand words of 'Gorilla Sign Language', and spoke to her in English from a young age. Koko's abilities remain disputed, but according to those who spent time with her, Koko used language the same way people do – and exhibited plenty of other 'human' qualities too. For example, Koko was adept at lying: she would often blame others for thefts or breakages, choosing those who were present at the time, or whom she disliked. She was also highly self-conscious. She loved to play with dolls, and often signed to them, but would immediately stop if she thought she was being observed.

Koko passed the mirror test with ease.[22] Indeed, her widespread fame during her lifetime originated in a *National Geographic* cover which depicted her taking her own photo in the mirror. Another gorilla who passed the test was Otto, a forty-five-year-old male who since the age of two had lived in an 'enriched' environment at the Suncoast Primate Sanctuary in Florida, where he was provided with activities such as foraging, watching television, painting and regular contact with human trainers.[23] It seems that supposedly innate characteristics – or at least their presentation – can actually be developed in time, providing the environment and the body pattern to support them exist.

The question of self-awareness gets even more complex in the case of Michael, an eighteen-year-old gorilla who lived with Koko at the Gorilla Foundation. He had a vocabulary of over 600 signs, many of them taught to him by Koko. Famously, he was believed to have described his mother's death at the hands of poachers in Cameroon in a sequence of signs: 'Squash meat gorilla. Mouth tooth. Cry sharp-noise loud. Bad think-trouble look-face. Cut/neck lip girl hole.'

Like Koko, Michael could be self-conscious. He could also be quite destructive, with a history of breaking equipment, so when he was tested for self-recognition with the mirror test, the mirror and the experimenters stayed outside the room, peering in. Although he'd previously shown plenty of self-interest in mirrors, when he was marked with a large dot of dye on his nose, he started behaving oddly. On approaching the mirror, he froze and leaned forward, carefully inspecting himself. He turned his head from side to side, looking at his face from different angles. And then he asked for the lights to be turned off. The experimenters refused, but Michael kept asking for the lights to be turned off, and the drapes to be closed. Eventually, he retreated to the back of the room, turned his back on the watchers, and wiped his nose on the wall until the mark was gone.[24] Michael's reaction suggests not only self-recognition but another significant and much-contested quality of complex cognition: theory of mind.

Theory of mind goes beyond simple recognition of the self distinct from other individuals: it implies the ability to think about the inner lives of others, to imagine their mental states, and to act accordingly. Beyond the simple interaction of the mirror test, we glimpse a much broader and more complex intelligence at work.

What are we to make of all these radically different abilities and outcomes? As we've seen, different species pass the test in different ways: some display strong relationships to the mirror, but refuse the mark test, others develop the ability in radically different ways, or confound our expectations based on their species' known tendencies. The mirror test is of course only one kind of test, for one very specific component of what we think of as intelligence – but its lessons should be applied to every single claim we make about the supposed intelligence or otherwise of all beings, including humans. Even when the results are not merely the effects of our own biases and limitations, they only really tell us how much we don't know.

It turns out that mirror self-awareness isn't even that well distributed across human individuals and cultures. Adults with schizophrenia often fail to recognize themselves in mirrors, and struggle with theory of mind as well. The oft-cited 'fact' that human children pass the mirror test – and thus develop self-recognition – at around eighteen months old turns out to be itself biased and only partly true. Those

tests are based on Western children, primarily in the US and Canada, and don't hold up in tests performed in Africa, South America and the Pacific islands.[25] That doesn't mean that non-Western kids aren't self-aware. It means that our testing processes and analyses are culturally biased in ways we don't recognize even when we do them on other humans, let alone on other species.

It's striking that the gorillas in particular had to have much of their gorilla-ness taken away from them to make these human-like behaviours legible to us. Koko and Michael were removed from their natural habitats and lived in specialized enclosures with extended contact with humans for most if not all of their lives. The qualities that make them seem intelligent to us were contingent on them being trained into human-like patterns of behaviour and sociality. Yet other forms of interaction, which we'll come to shortly, don't make this demand, and in these interactions we see other – but no less clear – signs of intelligence manifesting. Nevertheless, they depend on humans being able to read non-human signs – they depend on an overlap in the *umwelt*. That this is unlikely to ever extend to, say, ants, means that we will never be able to make the same scientific determination about such creatures. But that certainly doesn't mean they're not intelligent, as our unpicking of the various experiments we've tried thus far should intimate. Rather, if we are truly to appreciate what non-human intelligence might consist of – and thus transform our understanding of our own abilities and those of others – we need to stop thinking about intelligence as something defined by human experience. Instead, we must from the outset think about intelligence as something more-than-human.

It turns out there are many ways of 'doing' intelligence, and this is evident even in the apes and monkeys who perch close to us on the evolutionary tree. This awareness takes on a whole new character when we think about those non-human intelligences which are very different to us. Because there are other highly evolved, intelligent and boisterous creatures on this planet that are so distant and so different from us that researchers consider them to be the closest things to aliens we have ever encountered: cephalopods.

Cephalopods – the family of creatures which contains octopuses, squids and cuttlefish – are one of nature's most intriguing creations

They are all soft-bodied, containing no skeleton, only a hardened beak. They are aquatic, although they can survive for some time in the air; some are even capable of short flight, propelled by the same jets of water that move them through the ocean. They do strange things with their limbs. And they are highly intelligent, easily the most intelligent of the invertebrates, by any measure.

Octopuses in particular seem to enjoy demonstrating their intelligence when we try to capture, detain or study them. In zoos and aquariums they are notorious for their indefatigable and often successful attempts at escape. A New Zealand octopus named Inky made headlines around the world when he escaped from the National Aquarium in Napier by climbing through his tank's overflow valve, scampering eight feet across the floor, and sliding down a narrow, 106-foot drainpipe into the ocean. At another aquarium near Dunedin, an octopus called Sid made so many escape attempts, including hiding in buckets, opening doors and climbing stairs, that he was eventually released into the ocean. They've also been accused of flooding aquariums and stealing fish from other tanks: such tales go back to some of the first octopuses kept in captivity in Britain in the nineteenth century, and are still being repeated today.

Otto, an octopus living in the Sea-Star Aquarium in Coburg, Germany, first attracted media attention when he was caught juggling hermit crabs. Another time he smashed rocks against the side of his tank, and from time to time would completely rearrange the contents of his tank 'to make it suit his own taste better', according the aquarium's director. One time, the electricity in the aquarium kept shorting out, which threatened the lives of other animals as filtration pumps ground to a halt. On the third night of the blackouts, the staff started taking night shifts sleeping on the floor to discover the source of the trouble – and found that Otto was swinging himself to the top of his tank, and squirting water at a low-hanging bulb that seemed to be annoying him. He'd figured out how to turn the lights off.[26]

Octopuses are no less difficult in the lab. They don't seem to like being experimented on, and try to make things as difficult as possible for researchers. At a lab at the University of Otago in New Zealand, one octopus discovered the same trick as Otto: it would squirt water at light bulbs to turn them off. Eventually it became so frustrating to

have to continually replace the bulbs that the culprit was released back into the wild. Another octopus at the same lab took a personal dislike to one of the researchers, who would receive half a gallon of water down the back of the neck whenever they came near its tank. At Dalhousie University in Canada, a cuttlefish took the same attitude to all new visitors to the lab, but left the regular researchers alone. In 2010, two biologists at the Seattle Aquarium dressed in the same clothes and played good cop/bad cop with the octopuses: one fed them every day, while the other poked them with a bristly stick. After two weeks, the octopuses responded differently to each, advancing and retreating, and flashing different colours. Cephalopods can recognize human faces.[27]

All these behaviours – as well as many more observed in the wild – suggest that octopuses learn, remember, know, think, consider and act based on their intelligence. This changes everything we think we know about 'higher order' animals, because cephalopods, unlike apes, are very, very different to us. That should be evident just from the extraordinary way their bodies are constituted – but the difference extends to their minds as well.

Octopus brains are not situated, like ours, in their heads; rather, they are decentralized, with brains that extend throughout their bodies and into their limbs. Each of their arms contains bundles of neurons that act as independent minds, allowing them to move about and react of their own accord, unfettered by central control. Octopuses are a confederation of intelligent parts, which means their awareness, as well as their thinking, occurs in ways which are radically different to our own.

Perhaps one of the fullest expressions of this difference is to be found, not in the work of scientists, but in a novel. In his book *Children of Time*, science fiction writer Adrien Tchaikovsky conceptualizes octopus intelligence as a kind of multi-threaded processing system. For the space-faring octopuses in *Children of Time*, their awareness – their consciousness – is tripartite. Their higher functions, which Tchaikovsky calls the 'crown', are embedded in their head-brain, but their 'reach', the 'arm-driven undermind', is capable of solving problems independently – sourcing food, opening locks, fighting or fleeing from danger. Meanwhile, a third mode of thinking and communicating, the 'guise', controls the strobing and spotting of the octopuses' skin, 'the chalkboard of the brain', where it doodles its thoughts from moment to moment. In this way, the octopuses freewheel through space, constructing ships, habitats and whole societies which owe as much to bursts of emotion, flights of fancy, acts of curiosity and boredom, as they do to conscious intent. Tchaikovsky's octopuses are lively, frantic, bored, creative, distracted and poetic – all at the same time: a product of the constant dialogue and conflict within their own nervous systems. As Tchaikovsky tells it, octopuses are multiple intelligences in singular bodies.[28]

Tchaikovsky based his research on visits to the Natural History Museum in London, conversations with scientists and his own background as a zoologist. But what are we to make of such creatures – such intelligences – that require the tools of science fiction to make them intelligible to us? How can they appear so extraordinarily other, yet exist on the same planet, part of the same evolutionary process, as us?

The kind of self-awareness which we can observe with the mirror test – the kind that is most like our own – seems to have appeared in apes somewhere between the bonobo and the orang-utan, or between 18 and 14 million years ago. That's when one of the qualities which make up our kind of intelligence seems to have evolved. Humans parted ways with chimpanzees only about six million years ago, so it's understandable that our intelligence might be similar to theirs. But primates split from other mammals around 85 million years ago, while mammals themselves appeared distinct from other animals over 300 million years ago. To find a common ancestor with cephalopods, we need to go back twice that far, to 600 million years ago.

In his book *Other Minds*, the philosopher Peter Godfrey-Smith imagines who this common ancestor might have been. Although we cannot know for sure, it was most likely some kind of small, flat worm, just millimetres long, swimming through the deep, or crawling on the ocean floor. It was probably blind, or light-sensitive in some very basic way. Its nervous system would have been rudimentary: a network of nerves, perhaps clustered into a simple brain. 'What these animals ate, how they lived and reproduced,' he writes, 'all are unknown.' It's hard to imagine something less like us, yet alive, than tiny near-blind worms wriggling on the ocean floor. But we come from them, and so does the octopus.

Six hundred million years down the evolutionary tree – and 600

million up the other side too. While that distance makes all the obvious differences between us and the octopus understandable, it makes the similarities even more startling.

One of the most remarkable features of octopuses is their eyes, which are remarkably like our own. Like ours, their eyes consist of an iris, a circular lens, vitreous fluid, pigments and photoreceptors. In fact, the octopus eye is superior to ours in one notable way: because of the way they develop, the fibres of the optic nerves grow behind the retina rather than through it, meaning they lack the central blind spot common to all vertebrates. And this difference exists because the octopus eye evolved entirely separately from our own, starting from that blind flatworm 600 million years ago, along an entirely different branch of the evolutionary tree.

This is an example of convergent evolution. The octopuses' eye evolved to do much the same thing as our eye, entirely separately but only slightly differently. Two incredibly complex, but startlingly similar structures appeared in the world, by different routes, in different contexts. And if something as complex and adaptive as the eye can evolve more than once, then why can't intelligence do the same?

In Chapter 4, we'll explore further how this idea of branching and splitting of the evolutionary tree is overly simplistic, if not entirely false. For now, let's simply imagine it this way: the tree of evolution bears many fruits and many flowers, and intelligence, rather than being found only in the highest branches, has in fact flowered everywhere.

The intelligence of the octopus is one such flower. As Godfrey-Smith puts it, 'Cephalopods are an island of mental complexity in the sea of invertebrate animals. Because our most recent common ancestor was so simple and lies so far back, cephalopods are an independent experiment in the evolution of large brains and complex behaviour. If we can make contact with cephalopods as sentient beings, it is not because of a shared history, not because of kinship, but because evolution built minds twice over.' If twice, then likely many more.

From the octopus, then, we learn several important things. First, that there are many ways of 'doing' intelligence: behaviourally, neurologically, physiologically and socially. This bears repeating: intelligence is not something which exists, but something one does; it is active, interpersonal and generative, and it manifests when we think and act.

e already learned – from the gibbons, gorillas and macaques – telligence is relational: it matters how and where you do it, rm your body gives it, and with whom it connects. Intelligence omething which exists just in the head – literally, in the case of pus, who does intelligence with its whole body. Intelligence is ong many ways of being in the world: it is an interface to it; it he world manifest.

igence, then, is not something to be tested, but something to be ed, in all the multiple forms that it takes. The task is to figure to become aware of it, to associate with it, to make it mani- s process is itself one of entanglement, of opening ourselves to communication and interaction with the totality of the more- nan world, much deeper and more extensive than those which erformed in the artificial constraints of the laboratory. It changing ourselves, and our own attitudes and behaviours, an altering the conditions of our non-human communicants. us scientific studies can only tell us so much about the actual f non-human lives; mostly, they just tell us about our own hey also tell us about the structure of science itself: a human- ay of knowing about a human-centric world. But just because ach is limited, it does not follow that such realities are inaccess- wholly or partially, by other means – and even to scientists.

ng in the 1970s, and for a period of more than twenty-five primatologist Barbara Smuts explored the behaviour of iving free across Kenya and Tanzania. The baboons she came est she called the Eburru Cliffs troop, named after a rocky the Great Rift Valley near Lake Naivasha. At one point, she y day for almost two years with the troop, joining them as at dawn, and travelling with them until they found a resting htfall. As a result, she gained unique insights into baboon as well as an appreciation for, and sympathy with, many heir lives and minds which are not readily classifiable. tressed that this famili

other creatures. Palaeolithic hunters learned about the giant bear the same way the bear learned about them: through the intense concentration and fully aroused senses of a wild animal whose life hangs in the balance. Our ancestors' survival depended on exquisite sensitivity to the subtle movements and nuanced communication of predators, prey, competitors, and all the animals whose keener senses of vision, smell, or hearing enhanced human apprehension of the world.'[29] For Smuts, this sensitivity could be recovered – and was, for her, by her own interactions with the baboons.

In order to accommodate the baboons to her presence, Smuts would approach the troop on open ground, slowly moving towards them and stopping any time they seemed alarmed and moved away. As she became attuned to their behaviour, she started to pick up on more subtle signals – mothers, for example, would call their infants closer before a general alarm was sounded – which allowed her to draw closer still. Eventually, she was able to move among them freely.

This ability to move freely among another species, Smuts emphasizes, had less to do with the baboons becoming habituated to her presence, than with her adjusting her behaviour to suit them. She learned to move a little, and think a lot, like a baboon, picking up on their behaviour not merely as a scientist, but as a guest. In return, the baboons started to treat her as a subject of communication rather than an object of fear – that is, they realized that a dirty look rather than a general alarm would suffice to make her move away, and over time a greater range of gestures and signals arose between them. Research scientists, Smuts complained, are often told that they should ignore or move away from the subjects of their study if they come too close or try to interact with them. Such behaviour precludes meaningful interaction, as it would in any social group, so prevents most researchers even seeing the behaviour they're trying to study.

Smuts soon discovered she could get a lot closer to the baboons if troop. When meeting one another, a grunt or a facial expression conveys an expectation of a relationship – so when Smuts returned the grunts and gestures of her companions, they accepted her more. To ignore a baboon – or any other social animal – is not a neutral act. We might say that the same is true of our relationship to the world itself.

As a result of her willingness to engage with the baboons, Smuts began to learn more than she expected from them. Over time, her awareness of the world around the troop began to change too. Her attitude to the weather, for example, began to shift. In the initial months of her study, she'd find herself looking for shelter the moment rain clouds appeared on the horizon, but over time she became baboon-like in her attitude. The baboons didn't like getting wet any more than she did, but they stayed in the open far longer, making the most of feeding time before, at the very last moment, dashing for the protection of rocks and trees. After a while, Smuts found herself doing likewise: 'I could not attribute this awareness to anything I saw, or heard or smelled; I just knew. Surely it was the same for the baboons. To me, this was a small but significant triumph. I had gone from thinking about the world analytically to experiencing the world directly and intuitively. It was then that something long slumbering awoke inside me, a yearning to be in the world as my ancestors had done, as all creatures were designed to do by aeons of evolution. Lucky me. I was surrounded by experts who could show the way.'

The appreciation of outer behaviours tends inevitably towards a sensitivity to inner lives – and, in time, Smuts felt a change in her own sense of identity. 'The shift I experienced is well described by millennia of mystics but rarely acknowledged by scientists. Increasingly, my subjective consciousness seemed to merge with the group-mind of the baboons. Although "I" was still present, much of my experience overlapped with this larger feeling entity. Increasingly, the troop felt like "us" rather than "them". The baboons' satisfactions became my satisfactions, their frustrations my frustrations.' She describes sharing the hunger of the troop, her elation when they killed, and her mouth watering at the sight of fresh meat – despite being a vegetarian. 'I had never before felt a part of something larger, which is not surprising, since I had never so intensely

coordinated my activities with others. With great satisfaction, I relinquished my separate self and slid into the ancient experience of belonging to a mobile community of fellow primates.'

One incident which she shared with a different troop of baboons in Tanzania's Gombe Stream National Park seemed to capture a kind of experience and sensibility which is not only impossible to classify scientifically in animals, but which mirrors the unclassifiable experiences of humans ourselves. We call it spirituality. Late one evening the baboons were making their way to a sleeping place, down a small stream they often travelled along, which was interspersed with many small pools. Without any obvious signal, each of the baboons sat down on a smooth stone surrounding one of the pools, and for half an hour (by human reckoning) they sat alone or in small clusters, completely quiet, staring at the waters. Even the normally boisterous juveniles slipped into quiet contemplation. Then, again at no perceptible sign, they stood up and resumed their journey in quiet procession.

Smuts witnessed this behaviour just twice; what's more, she is the only researcher ever to do so. Whether it is particular to the group, or a manifestation of something broader, we don't know, but for Smuts the episode appeared more than anything like a religious experience – she uses the Buddhist term *sangha*, meaning a community of devotees engaged in meditation and spiritual practice. 'I sometimes wonder if, on those two occasions, I was granted a glimpse of a dimension of baboon life they do not normally expose to people. These moments reminded me how little we really know about the "more-than-human world".'

Gombe, where Smuts sat with the meditating baboons, is the location of Jane Goodall's decades-long research with chimpanzees – the longest uninterrupted study of any animals, anywhere. Goodall, too, has written of her glimpses into the inner lives of the animals she studied and lived alongside: states of mind which seemed deeply significant yet were ultimately untestable and fundamentally inaccessible.[30]

Deep in the forest around Gombe are spectacular waterfalls, which for the chimpanzees seemed to hold a deep fascination: 'Sometimes as a chimpanzee – most often an adult male – approaches one of these falls his hair bristles slightly, a sign of heightened arousal,' Goodall recounts. 'As he gets closer, and the roar of falling water gets louder, his pace quickens, his hair becomes fully erect, and upon reaching the stream he may perform a magnificent display close to the foot of the falls. Standing upright, he sways rhythmically from foot to foot, stamping in the shallow, rushing water, picking up and hurling great rocks. Sometimes he climbs up the slender vines that hang down from the trees high above and swings out into the spray of the falling water.' What Goodall calls the 'waterfall dances' may last for ten or fifteen minutes. She considers them to be 'precursors of religious ritual'.

Goodall also writes about the chimpanzee's rain dances, performed at the onset of heavy downpours. During these displays, the chimpanzees will grasp saplings and low branches and sway them rhythmically back and forth, then move forward slowly while loudly slapping the ground with their hands, stamping their feet and hurling rocks. While loath to draw firm conclusions from such displays, Goodall associates them with 'feelings akin to wonder and awe' and notes that afterwards the performer will sit quietly for some time watching the water, much like Smuts's baboons around the pools.

Goodall attributes her own open-mindedness to matters of science and religion to starting out in the field without any specialized scientific training. She was originally hired by the anthropologist Louis Leakey to study the primates at Gombe because he wanted researchers 'unbiased by the reductionist thinking of most ethnologists'. The result of her fifty-five years of close association with both chimpanzees and scientific thinking has not been a narrowing of her perspective. Rather, 'the more science has discovered about the mysteries of life on Earth, the more in awe I have felt at the wonder of creation, and the more I have come to believe in the existence of God.'

For Smuts and Goodall, intelligence – whatever it is – manifests in this kind of awareness and belief, this kind of wonder and awe. It is here that our thinking on intelligence breaches the mind completely, and becomes part of larger questions about culture and consciousness, about being and living in a more-than-human world.

This, then, is how we might become aware of *real* intelligence: that is, the kind that exists everywhere and between everything. It is made evident not by delineating and defining, not by splitting, reducing, isolating and negating, but by building, observing, relating and feeling. Intelligence, when we perceive it at play in the world, is not a collection of abstract modes: a concatenation of self-awareness, theory of mind,

emotional understanding, creativity, reasoning, problem-solving and planning that we can separate and test for under laboratory conditions. These are simply reductive and all-too-human interpretations of a more boundless phenomenon. Rather, intelligence is a stream, even an excess, of all these qualities, more and less, manifesting as something greater, something only recognizable to us at certain times, but immanent in every movement, every gesture, every interaction of the more-than-human world.

To think of intelligence in this way is not to reduce its definition, but to enlarge it. Anthropocentric science has argued for centuries that redefining intelligence in this way is to make it meaningless, but this is not the case. To define intelligence simply as what humans do is the narrowest way we could possibly think about it – and it is ultimately to narrow ourselves, and lessen its possible meaning. Rather, by expanding our definition of intelligence, and the chorus of minds which manifest it, we might allow our own intelligence to flower into new forms and new emergent ways of being and relating. The admittance of general, universal, active intelligence is a necessary part of our vital re-entanglement with the more-than-human world.

In this thought, I believe, resides the real promise of 'artificial' intelligence. That is to say, if intelligence, rather than being an innate, restrictive set of behaviours, is in fact something which arises from interrelationships, from thinking and working together, there need be nothing artificial about it at all. If all intelligence is ecological – that is, entangled, relational, and of the world – then artificial intelligence provides a very real way for us to come to terms with all the other intelligences which populate and manifest through the planet.

What if, instead of being the thing that separates us from the world and ultimately supplants us, artificial intelligence is another flowering, wholly its own invention, but one which, shepherded by us, leads us to a greater accommodation with the world? Rather than being a tool to further exploit the planet and one another, artificial intelligence is an opening to other minds, a chance to fully recognize a truth that has been hidden from us for so long. Everything is intelligent, and therefore – along with many other reasons – is worthy of our care and conscious attention.

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In this chapter, we've explored only a tiny fragment of the vast literature of intelligence. To do justice to such a range of thinking – both our own and that of other beings – would require numerous books, many already in existence and many yet to be written. What I have sought to do is to illustrate the complexity of such thinking, the deep uncertainty of the subject and, quite frankly, the colossal failure of many of our current ways of thinking about it, both popular and scientific.

On the one hand, these are the hallmarks of good scientific practice: frequent failure, openness to debate and willingness, even a desire, to be proved wrong and learn from the experience. On the other hand, it suggests that there are all kinds of gaps, misunderstandings and outright fallacies in our thinking about intelligence in general, which we all too often ignore or gloss over to the detriment of our own thinking. Under such circumstances, it should be no surprise that the kinds of 'intelligence' we are creating in our machines are so baffling, frightening and misdirected. We are only beginning to learn the true meaning of the word, even as we put it to work. If I have done one thing here, I hope it has been to destroy the idea that there is only one way of being and doing which deserves the name 'intelligence' – and even, perhaps, that intelligence itself is part of a greater wholeness of living and being which deserves our wider attention.

This claim underlies a larger one. Both scientific and popular thought tend towards the conclusion that there are ultimately single answers to single questions. What is intelligence? Who possesses it? Where do they fit into our rigid structures and hierarchies of thought and dominion? Perhaps – whisper it – *this just isn't how the world works*. The closer we examine and the more forcefully we interrogate and attempt to classify the world, the more complex and unclassifiable it becomes. Taxonomy after taxonomy breaks down and falls apart. In part this is a result of our own innate limitations, the possibly insuperable problem of our own *umwelt* and human ways-of-being. But it is also a problem of entanglement: the fact that in the more-than-human world, everything is hitched to everything else, and there are no hierarchies: no 'higher' or 'lower'; none more, or less, evolved. Everything is intelligent. Now what?

2
Wood Wide Webs

At the beginning of 2018 I was invited to give a talk at a big, glossy event in Vancouver. The topic of the talk was to be some of the darker aspects of the internet, and particularly the effects of online video and algorithms on children: a grim subject which I didn't relish delving into. On the other hand, I'd never been to the west coast of Canada before, and the trip promised encounters with interesting new people and landscapes.

As a speaker at the conference, I was offered a range of regional 'experiences', most of which I missed out on as I hid in my hotel room, frantically rewriting and rehearsing my talk. But there was one that seemed too good to miss: a tour of the redwood forests on the city's edge, led by a biologist from the University of British Columbia. So I climbed aboard a bus with a couple of dozen other attendees and went for a walk in the forest.

Our guide was Professor Suzanne Simard, who has spent decades studying the giant redwood forests of Canada's Pacific coast. As we walked among the mossy trunks, she explained how the huge trees were intimately connected to one another – and to places far outside the forest itself. For example, a significant proportion of the essential nitrogen that the trees and other forest plants take up through their roots is ultimately derived from very far away indeed – from the middle of the Pacific Ocean, thousands of miles distant.

We know this because there's a particularly heavy nitrogen isotope called nitrogen-15 which is much more common in marine algae than in most terrestrial vegetation. Yet it's found in surprising amounts in coastal forests, and the way it gets there is quite marvellous. The fish which feed on algae and phytoplankton in the deep ocean become