PART 1: TOWARDS A NEW THEORY OF BEHAVIOURAL EVOLUTION

1 DOES DARWIN DO INSTINCTS?

Before he was half way through the letter, Charles Darwin's heart must have been racing. He read the letter several times, examining every word. But no matter how many times he read it, its terrible implications were always the same – his life's work, fame and honour hung by a spider's thread over the precipice of total ruination. The letter that arrived on June 18th 1858 was from fellow naturalist Alfred Wallace, holed up on the Indonesian island of Ternate where he was collecting specimens to sell to naturalists like Darwin. It included a paper, entitled *On the Tendency of Varieties to Depart Indefinitely From the Original Type.*[1] This concise, simply written paper, that took Wallace only two days to write, is breathtaking in its scientific audacity – a creative tour de force that quietly, modestly but convincingly proposed a revolutionary new theory of physical evolution. Ironically, there was probably only one person on the planet at the time who could appreciate the ground-breaking significance of this monumental theory – and that person was Charles Darwin. Why? Because Wallace's paper described in uncanny detail the very process that Darwin had been working on for the last twenty years.

'I never saw a more striking coincidence,' Darwin wrote to his friend, Charles Lyell the very same day, 'If Wallace had my M.S. sketch written out in 1842 he could not have made a better short abstract!'

Not only that, but in the accompanying letter, Wallace naively asked Darwin if he thought the essay 'worthy', to pass it on to Sir Charles Lyell at the Linnean Society with a view to publication.

The personal impact of this letter was very much on my mind the day I visited Darwin's country manor house in Kent, just outside London. As I strolled around the beautifully manicured gardens of Down House on that balmy summer's afternoon, it was not difficult to imagine Darwin opening the letter in his spacious but cluttered office, then setting off for one of his three daily strolls to think about the horrendous implications of Wallace's letter. How ironic I thought, as I retraced Darwin's daily walk behind his house, that Darwin had been working on his own theory of Natural Selection for two decades; shaping, fine-tuning and double-checking in an almost obsessive determination to ensure his theory would withstand the rigorous scrutiny that was sure to follow its publication. His radical, if not seditious ideas, perhaps more than those of any other scientist, challenged the prevailing orthodoxy of the Christian church. Rather than the earth being created by God in one frenetic week, Darwin's theory extended the schedule of creation to billions of years. And instead of human beings being made 'in the image of God,' Darwin proposed an evolution from simpler forms that extended back to the most primitive microscopic life forms.

The theory and its discovery, however, were subject to the rules of scientific precedent. The honour would go to whoever published first. Darwin was devastated; impaled as the Victorians may well have said, upon the horns of a dilemma. In her scholarly two-volume biography of Darwin, Janet Brown tells us that Darwin was stunned. 'He was well and truly forestalled. It was impossible to pretend otherwise.'[2]

Sure, Darwin was a dedicated naturalist whose ultimate objective was the furtherance of biological science; but he was also a man, proud and ambitious as most great men are, and to see twenty years of painstaking research being beaten at the post was infuriating. 'All his originality was smashed,' writes Brown, 'all his years of hard work suddenly useless. For a moment, the news hit him like the death of a child. Then, his mind churned with painful emotions – not anxiety or panic, he confessed afterwards, but much baser feelings or mortification, possessiveness, irritation, and rancour, each flaring up one by one after the first unaccountable, humiliating surprise.'[3]

Peeved as he was, Darwin was also a highly moral person and, that very afternoon, he dutifully sent the monograph on to Lyell. In a covering letter, he acknowledges he has no one else to blame but himself. After all, Lyell himself had warned him years ago that if he didn't publish his theory, eventually someone else would. 'Your words have come true with a

vengeance,' Darwin wrote, 'that I should be forestalled… So all my originality, whatever it may account to, will be smashed.'[4]

Fortunately, twelve years earlier, Darwin had sent a draft of his theory to botanist Sir Joseph Hooker and this allowed Lyell and Hooker to decide the issue of precedence as a dead-heat. Both papers were read at a meeting of the Linnean Society on July 1, 1858.[5,6] After this salutary warning, Darwin followed it up expeditiously with the publication of *The Origins of Species by Means of Natural Selection*[7] and the rest, as they say, is history.

Despite the expected wave of controversy, Darwin's twenty years of research, complemented by pioneering work on genetics by the brilliant amateur botanist, Gregor Mendel,[8] Sutton and Boveri,[9,10,11,12] Thomas Morgan[13,14,15] and others, eventually became the most important contribution ever to the biological sciences and the mainstay of biology in the twenty-first century. Today, despite assaults from (mainly American) creationists, Darwin's theory of natural selection remains the much respected orthodoxy.

Mutations, mutations, mutations

At the core of both Darwin and Wallace's theory was their discovery that biological evolution is driven by what they called 'variables', 'variations from the typical form', 'slight deviations of bodily structure' and hereditary elements of 'unknown causes' that resulted in physical differences between individuals – even those of the same species.[16,17] Of course, in Victorian times, neither men knew anything about the nascent science of genetics (represented at the time only by Gregor Mendel's revolutionary but almost unread paper on hereditary,) so their understanding of the molecular processes behind evolution was almost nonexistent. Today of course, we know that 'variations' are caused by random mutations in Deoxyribonucleic acid (DNA.) See Box.

DNA MUTATIONS

Mutations occur when DNA, the molecule of inheritance, (which looks somewhat like a tiny twisted ladder) reproduces itself. Instead of making an exact copy of a gene, something goes amiss. Usually the error is confined to one 'letter' or nucleotide although some mutations involve the duplication, deletion or transposition of a whole chromosome. These randomly occurring mutations are the key to

evolution because they provide alternatives that can be tried out in the thrust and parry of the real world. Without them, evolution would grind to a ignominious halt.

When they occur, mutations may do one of three things. Mostly they do nothing at all; at least they do no damage. This is because only a tiny section of our genome actually contains coding functional genes.[A] In fact, if a human DNA (deoxyribonucleic acid) molecule was stretched out to its full 182 cm length, (about the size of a tall man) all the coding genes required to make a person are contained in a minuscule stretch only 2.5 cms long.[18] That's about the width of your thumb. The rest is a genomic desert, what was often referred to as 'junk DNA' (genes that don't actually contain workable instructions) so it doesn't matter too much what happens there. Even when a mutation occurs in the minuscule 1.5% of the human genome that does include coding genes,[19],[B] the consequences are not necessarily serious. Being born with big ears or even an extra finger will not kill you.

Secondly mutations can be harmful, or what biologists call either 'deleterious' or 'maladaptive'. Then the orderly workings of the chromosomes are disrupted, often resulting in disease, physical or mental abnormalities, cancers and other ailments that can kill or maim the organism before it produces offspring. In these cases, the deleterious mutant gene dies with their luckless owner, culled by the relentless efficiency of natural selection. In humans for example, mutations involving gene deletions alone were estimated in 1996 to be responsible for over 150 genetic conditions in humans, while the simplest types of mutations, (known as 'point mutations') were found to be responsible for a massive 3532 human genetic diseases.[20]

Thirdly, mutations can very occasionally improve things, resulting in a longer, healthier life for the organism – often resulting in having more offspring. A mutation that even slightly increases an animal's sense of smell may help it find more food and detect predators earlier, theoretically leading to a longer life and more offspring. If this mutation is passed on to the

[A] A gene is simply a sequence of DNA that contains the recipe (or code) to fabricate a functional protein which is used to make the cells from which all life forms are built.

[B] While the public Human Genome Group found that '1.5% of the genome was represented in sequenced clones,' the privately funded Celera Inc. study calculated that just 1.1% of the genome codes for proteins.

next generation and gradually spreads throughout the entire species – it becomes what biologists call ‘fixed’.

So a mutation is either insignificant or at least not too serious (neutral); kills the organism prematurely (deleterious); or enhances its life and reproductive capacity (adaptive.) All three illustrate how mutations are the real powerhouse of Darwin’s natural selection process, effectively shaping the physiology of organisms.

While mutations are completely crucial to the Darwinian evolutionary process, they don’t represent the whole story – in fact, they’re only half the story. If you put Darwin’s natural selection evolutionary process under a microscope, you discover it is not a single process as the term implies. It actually requires two quite distinct processes to achieve evolution. The first step is producing what Darwin called ‘favourable individual differences and variations’ but which we now know to be inheritable mutations. The second step in the natural selection process has often been described as ‘market forces:[21],[22] the relentless rat race that sorts the winners from the losers: where ‘when the going gets tough, the tough get going’ and ultimately where only the toughest survive. Except that in biology, the measure of success is not economical clout or physical toughness, it’s ‘fitness’, an old Victorian term that refers ultimately to how many offspring an organism produces.[C]

In this second step, adaptive (or *beneficial*) mutations that increase reproductive success tend to be permanently selected, inherited and passed down through the generations (they become ‘fixed’,) while those deleterious mutations that reduce the chances of having offspring inevitably get weeded out (what is called being ‘selected against’).

Evolution via Darwin’s natural selection process is mostly, although not always a slow and gradual process, but in the end, it can achieve remarkable results. Given enough time, Darwin said, it could turn microscopic organisms into blue whales. It can increase the thickness of an animal’s fur in winter (animals with thin wool simply die out), and it can increase the length of a peacock’s tail (females who prefer long tails won’t mate with small tailed peacocks.)[23] In

[C] The term ‘fittest’ doesn’t actually mean *physically fit*. It is simply a measure of an organism’s ability to survive.

this way, organisms have evolved, cell-by-cell, mutation-by-mutation from the primordial ooze to the Sea of Tranquillity.

Of course, when Darwin first published *On the Origins of Species by Natural Selection*,[24] he did not know about Mendelian hereditary, nucleic acids, exons or mutations of alleles. In fact, Darwin had almost no idea how the first part of natural selection (the mutational process) worked at all. Not surprisingly then, his theory tended to concentrate on the second step of the process – selection, which was within the grasp of Victorian scientific understanding. Still, he remained acutely aware, (as he noted in *Origin of Species*,) that "natural selection can do nothing until favourable individual differences or variations occur."[25]

When the new science of genetics started to test Darwin's theory in the twentieth century, it stood up incredibly well. As could be expected, some of his Victorian terms were updated and many of the details filled in to take into account what had been learnt about genes and genetics, but essentially Darwin's nineteenth century theory was not only substantiated, but considerably strengthened. This fusion of Darwin's theory with 20th century genetics became known as 'the modern synthesis,' a term first coined by Julian Huxley in 1942.

Even though many of Darwin's Victorian terms, were replaced with and other phrases from molecular biology (for example, 'favourable individual differences and variations' became 'genetic mutations' [26]), 'the modern synthesis' is still very much Darwin's theory although it is now often called 'NeoDarwinism' to recognise the important contributions of geneticists like Julian Huxley,[27] Theodosius Dobzhansky,[28] Ernst Mayr,[29] R. A. Fisher,[30] Sewall Wright,[31] J. B. Haldane[32] and others. For our purposes though, when Darwin talks about 'spontaneous variations of instincts,' or even 'variation', read 'genetic mutations'.

Having survived Watson and Crick's genetic revolution in the fifties, assaults from creationists who object to it *a priori*, not to mention the odd attack from respected biologists concerned about a few loose ends, Darwin's transcendent theory today rules supreme.

The Darwinian theory of instincts

The late British biologist John Maynard Smith once said that 'only two theories of evolution have ever been put forward: one, originating with Lamarck… the other, originating with Darwin'.[33] Darwin's natural selection theory, as the name implies, is an 'selectionist' theory,

because it argues that adaptive mutations are retained (or *selected*.) By comparison, the distinguished French biologist, Jean-Baptiste Lamarck believed the organism's environment directly *instructed* it with new traits – hence 'instructionism.'

One of the major repercussions of Darwin's selectionist theory was that it finally put paid to Lamarck's instructionist theory of evolution. Also called 'the inheritance of acquired characteristics, Lamarckian inheritance, or the theory of use and disuse, Lamarck's instructionist theory was popular in Darwin's time mainly because it tried to accommodate the role of the environment in the evolutionary process. In theory, Lamarckian evolution means that if a rat develops bigger leg muscles from running on a treadmill, its offspring may inherit its improved musculature. In essence, Lamarckianism proposes that organisms can pass on physical characteristics they have acquired from the environment during their lifetime.

However, despite at one stage being championed by Darwin himself, Lamarckianism contains a fatal flaw. If you inherit physical traits like bigger muscles from your father, you might also inherit his tired old skin and ailing heart. If you inherit your mother's callused fingers (useful if like her you dig for tubers most days) you may also inherit her lumbago or herniated vertebrate from years of stooping. So, while there may be advantages in inheriting some acquired physical characteristics, a potentially fatal downside renders the system untenable. In fact, we now know that the DNA molecule is designed to make sure that physical traits are not acquired from the environment during the life of the individual. So important is it to prevent physical traits from being contaminated by acquired traits that the DNA molecule has evolved to be impervious to all but the most pernicious environmental influences. This is known in biology as 'the central dogma' and it simply means that under normal conditions, physical traits acquired during the life of an organism cannot be inherited to offspring.

After nailing the question of physical evolution in Chapter Four of *The Origin of Specie*s, (including a viable selectionist alternative to Lamarck's instructionist theory), Darwin suggests in Chapter Eight that natural selection might also be involved in shaping, modifying, culling and even creating new instinctive behaviours.

> 'Under changed conditions of life, it is at least possible that slight modifications of instinct might be profitable to a species; and if it can be shown that instincts do vary ever so little, then I can see no difficulty in natural selection preserving and

> continually accumulating variations of instinct to any extent that was profitable. It is thus, as I believe, that all the most complex and wonderful instincts have originated.'[34]

Taking into account what we now know about genes, this means that once an organism has encoded a behaviour into its genes (so that it is inheritable), then the genes that code for that behaviour will be subject to selection (market forces) that sorts them into adaptive, neutral or maladaptive.[35],[36],[37],[38]

Darwin's use of 'variables' (genetic mutations) and selection to explain 'instinct' (innate behaviour) appears sound. After all, if the two-step partnership of mutations and selection can accumulate over time to create new physical traits like kidneys, camouflaging, teeth and opposable thumbs, then it follows that the two-step process could also create adaptive inheritable behaviours. The mutational process would create behavioural circuits, instincts, emotions, motivations etc. while selection would sort through them, weeding out the failures and hardwiring in the adaptive behaviours. This seemed a plausible explanation for how instincts and other innate behaviours are formed.

Although physical evolution took centre stage in the late nineteenth and early twentieth century review of Darwinism, it was only when the new fields of behavioural genetics, evolutionary biology and, in the 1980s, evolutionary psychology emerged that Darwin's belief – that natural selection was also responsible for behaviour – could be re-examined. The notion that behaviour evolved via mutations just as physical characteristics did was so plausible, so downright commonsensical, it quickly became the undisputed orthodoxy in relation to behaviour, as exemplified in Helena Curtis's and Sue Barnes' 1989 university text book, *Biology (5th Ed.)*:

> The behavioural characteristics of an organism – its sensitivity to particular stimuli and its patterns of responses to those stimuli – are as much the product of natural selection as the shape of a tooth or a feedback loop that regulates blood pressure… The factors governing the evolution of behavioural characteristics are the same as those that apply to any other trait.[39]

In the same vein, the distinguished biologist W. D. Hamilton introduced his paper, *The Evolution of Altruistic Behaviour* with, 'It is generally accepted that the behaviour characteristic of a species is just as much the product of evolution as the morphology.'[40],[D] Assured by French biologist Richard Alexander that 'genes are the most persistent of all living units, hence on all counts the most likely units of selection',[41] geneticists confidently divided genes into those that encoded behaviour (behavioural genes) and those that encoded physical traits (somatic genes.) Selection, as exemplified by Alexander Alland in *Evolution and Human Behaviour* applies equally to both.

> Behavioural genes are subject to all the rules which apply to somatic genes. Mutations occur which alter behaviour; some traits are based on dominant genes, others on recessives, still others on codominance. Some traits are single-gene effects; others, particularly complex behavioural systems, are polygenetic.[42]

The new field of Ethology (the study of animal behaviour) also confirmed Darwin's idea from a genetic perspective. Konrad Lorenz devised a theory of 'fixed action patterns' which he considered his 'most important contribution to science'.[43] By treating the brain and its innate behaviours 'as equipment analogous to organs',[44] Lorenz reasoned that behaviour evolved 'exactly as organs do'.[45] This not only added weight to Darwin's theory and put the new science of ethology on a firm scientific footing, but won Lorenz the 1973 Nobel Prize (along with fellow ethologists Nikolaas Tinbergen and Karl von Frisch.)

The idea that random mutations and natural selection can shape innate behaviour fits in neatly with the idea that the brain (which manufactures behaviour) is itself a product of random mutation and selection. After all, it is a physiological organ just like the liver, heart and lungs. If the random mutation-selection partnership can create and hardwire brains, then it must surely create the behaviours that brains manifest.

This makes it easier to conclude that not only does the mutation-selection partnership create the physiology of each species (making tigers look like tigers and birds look like birds), it also

[D] 'Morphology' means the shape of an animal's body.

wires each species with its own unique behavioural characteristics so that tigers *act* like tigers and birds *act* like birds.

Despite Professor Anthony Barnett's reminder that 'In biology, nothing can be taken for granted, not even fundamentals of biological theory',[46] the new field of evolutionary psychology added its weight to the Darwinian model, using it to explain how humans acquired a whole raft of innate behaviours during their sojourn on the African savannas. Evolutionary psychologists assert that the neural networks in the human brain that codify the innate behaviours manifested daily in the corporate towers of Wall Street, on the battlefield and in homes were encoded in human genes purely by the combination of random mutations and natural selection. Evolutionary psychologists Leda Cosmides and John Tooby explain the nexus between evolutionary psychology and Darwinian orthodoxy:

> The brain came into existence and, over evolutionary time, accreted its present complex structure because, in ancestral populations, mutations that created or altered cognitive programs such that they more successfully carried out adaptively consequential information-processing tasks were differentially retained, replicated, and incorporated into our species' neural design.[47]

In effect, evolutionary psychologists maintain that random mutations act on the brain's neural circuits to produce new innate behaviours. In *The Selfish Gene*,[48] evolutionary biologist Richard Dawkins argued that natural selection chooses those genetic mutations that best ensure the survival of the genes themselves.

Despite the slight differences of emphasis and interpretation, Dawkins and the evolutionary psychologists are in accord with Darwin's basic theory – as revised by the modern synthesis. With everyone is in agreement, it is not surprising that when cognitive scientist Steven Pinker wrote *The Language Instinct*[49] (in which he developed the ideas of Noam Chomsky and others to claim that the capacity for human language is partially instinctive), he relied on the same Darwinian model to explain how this innate awareness of grammar and syntax may have evolved into human grammar genes:

> "Though we know few details about how the language instinct evolved, there is no reason to doubt that the principal explanation is the same as for any other complex instinct or organ, Darwin's theory of natural selection."[50]

So, bolstered by a coterie of eminent biologists, ethologists, geneticists, and evolutionary psychologists, natural selection has arrived in the twenty-first century as the pre-eminent behavioural orthodoxy – the only plausible explanation for how stable, inheritable behaviour (or instincts) evolve. Although there's continuing debate about whether instinct applies to humans to the same degree as non-human animals, (not to mention the interminable nature vs. nurture debate), when it gets down to it – there is only one evolutionary process and that is meant to explain everything. When biology teachers are asked to explain how behaviour evolves, they use exactly the same theory they use to explain physical evolution – new innate behaviours, emotions and instincts arise from random mutations of protein-coding genes that are selected because they provide an adaptive advantage.

This prevailing paradigm is taught daily in universities around the world, espoused in school classrooms and enunciated in Internet chat rooms. It is one of the least criticised or debated aspects of NeoDarwinian theory. There is only one problem with this well-oiled, much respected and seemingly coherent orthodoxy. There is growing evidence to suggest it is completely incorrect. And in the next chapter, I outline the case against random mutations.

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