1 NOW YOU ARE TWO: THE END OF THE BEGINNING?

Memories Are Made of This

How much do you remember about your life before your second birthday, during your infancy? Where you lived, your brothers and sisters, how your parents or the people who cared for you behaved, being breast- or bottle-fed and your first weaning foods?

Almost certainly, if you're honest, the answer to this question will be 'I can't remember any of it'.

But you might know people who have memories of a time when they were one year old, seeing someone from their baby cot or sitting in a high chair, perhaps tipping food onto the floor.

Most families love storytelling, and events in our early lives can easily become mythologised to seem as vivid in our minds as those experiences we had when we were older and consciously witnessed them. So while you might think that you have a memory of events in those first two years, on closer examination it usually turns out to be imagined, based on later experiences or what was told to you by people who were older. After all, it's quite likely that your family lived in the same home for more than just your first two years and even more likely that you had the same brothers and sisters and carers.

It's a natural human tendency to make connections between the past and the present and there are traditions in many cultures about this. They range from giving a child a name from a previous generation, to more complex

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beliefs, for example that the souls of ancestors live in hollow stones after their death until they are able to emerge to inhabit the bodies of children.

But *why* don't we remember anything about these formative two years of our lives?

Despite considerable research on how our minds work, the fact is that we don't know the answer to this question.

Later in our lives we can (usually) remember the first time that we met someone, especially if they turned out to be significant to us in some way. We can remember how, on that first occasion, we saw them and interacted with them as a new person, someone different from the people we'd met before.

But how did we know that they were new to us? That requires experience. Could it be that without having met lots of different people we can't say whether or not someone we meet is new to us?

Maybe what we call memories can't really occur until we are old enough to have built up a stock of experience on which to base new events or encounters. Memories require a system for categorising experience, for cataloguing it and filing it under headings that allow it to be retrieved later.

Without experience of what it is like to be a grown-up human being, how does the child grow up to be just that, a grown-up human being?

Without any experience or prior knowledge of what it is like to be a grown-up human being, how does the child manage to grow up to be just that, a grown-up human being?

It's a shame we can't remember events in those first 1,000 days because so much was happening to us then. We took our first steps, literally as well as metaphorically, in a challenging but stimulating new world.

The first two years of infancy are recognised by health professionals as being a critical phase in our development. So we need to delve deeper into them if we are to understand what makes each of us.

You Get That from Your Father

It's a source of delight, or perhaps sometimes of dismay, for parents to see some of their best, or possibly their worst, features reflected in their offspring. Why do some characteristics, from the length of noses to the ability to sing in tune, get passed from one generation to the next, while others do not? Is it largely a question of chance or the accident of development? How much is Nature and how much is Nurture? This an age-old question which has been debated many, many times and from different standpoints – social, emotional, religious, legal as well as scientific to name only a few. The balance of opinion has swung back and forth over the years as new evidence appeared and particular views gained prominence.

For many years the most widely accepted view has been that 'nature', our inborn characteristics which are hard to change, is driven by the genes which we inherited. Identifying and mapping all our genes was the amazing achievement of the Human Genome Project at the start of this millennium. Knowing this sequence seemed to hold most if not all of the answers to questions about human nature, including how the tiny embryo grows into a baby and why we differ as individuals. It was a little surprising that it turned out that we possess only 20,000–25,000 genes. Are these enough to make something as complicated as a person? In addition, it turned out that we share 99% of our genes with our nearest cousins, the chimpanzees. About

50% of our genes are the same as bananas. This made us realise that what our genes are – their nature and their sequence in the DNA strand – was only part of the story. Equally, or perhaps even more importantly, might be how those genes are used and the process which controls how they work during the development of a person, a chimp or a banana.

About 50% of our genes are the same as bananas

This challenge took us back to basics. At the end of the nineteenth century a monk named Gregor Mendel worked out the mathematics of inheritance from a series of breeding experiments using peas. He calculated rules by which certain characteristics are passed from one generation to the next by looking at the offspring of peas, with certain characteristics such as colour and skin texture, which he had cross-pollinated. Even though he had no idea of the existence of DNA, let alone the genes it makes up, it turned out that these characteristics are inherited in a strictly mathematical way, so that the likelihood of an individual pea plant having a particular characteristic could be calculated with certainty from the characteristics of its parent plants. Random effects, or effects of the weather had no influence on this inheritance.

These rules of so-called Mendelian inheritance apply to a few of our characteristics such as the colour of our eyes, and to some diseases which run in families such as cystic fibrosis. It is possible to predict the chance that a child will inherit these characteristics if we know the genetic make-up of the parents, just as Mendel was able to do with his breeding experiments in peas.

But most of our physical characteristics don't follow Mendel's rules. They may depend on the inheritance of a

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large number of genes, which interact to produce a characteristic and can be inherited in various combinations. The dependence on such a large number might give the appearance of a more random inheritance, and would have defeated Mendel's mathematics and his experimental design. Today we can explore such inheritance through our ability to define the nature of thousands of genes from an individual and having the software to look for patterns. But there is also another possibility which could explain why some of the variation in characteristics between members of a family do not appear to follow Mendel's rules. Other non-genetic factors during very early life, such as exposure to hormones or nutrients, can influence whether the inherited genes actually work in a way that leads to a characteristic being developed in the unborn baby. The tiny 'epigenetic' marks left on DNA alter the way cells in our bodies make vital proteins, and so our characteristics, and we talk more about them in Chapter 5.

Despite expectations, the publication of the Human Genome hasn't led to the identification of a strongly genetic basis for the explained inheritance of many of our characteristics. Nor has it explained the basis for risk of the chronic diseases which account for the majority of deaths worldwide every year, even though there is plenty of evidence that these diseases can be passed from one generation to the next.

And it's not just physical. Finding a purely genetic basis for inheritance becomes even more problematic with more complex characteristics like aspects of behaviour, such as aggression. It is complex because behaviour is the result of lots of parts of the brain working in conjunction with the rest of the body. Even in a 'simple' organism such as the fruit fly, which has about 10,000 fewer genes than we do, aggressive behaviour results from the action of numerous genes.

An often-quoted example of genetic influences concerns the differences in behaviours between boys and girls. After all, the sexes are genetically different, at least in terms of girls having two X chromosomes and boys one X and one Y chromosome. So how much of the behavioural differences between boys and girls is genetic, and how much is due to environmental factors?

This question has occupied child psychologists, researchers and those concerned with gender issues as well as, of course, billions of parents, for generations.

It is clear that a preference for dolls and pink clothes is not a genetic predisposition in girls. The preferences of our children and many of their behaviours are down to the encouragement they receive from the obvious delight in their parents or carers when they choose certain things, and the discouragement for other things. Don't forget that in the 1920s pink was still a 'boy's colour'.

One morning the boy had chewed his toast into the shape of a handgun and was shooting at his sister across the breakfast table

But of course it isn't just parents and carers – all sorts of other influences operate. We can only sympathise with the young parents who were determined that their little boy would not become an aggressive young lad like so many older children in the town where they lived. They were adamant that he would not see violence on TV, would have no toy soldiers and certainly no plastic swords or cannons. But kids will use their imagination to create their own games. Imagine their dismay when one morning the boy had chewed his toast into the shape of a handgun and was shooting at his sister across the breakfast table.

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Born Losers

The Nature versus Nurture distinction becomes really dangerous, and unethical, when it is used for social engineering or to argue for the maintenance of the status quo. The issue is encapsulated by the views of the psychologist Francis Galton who coined the terms Nature and Nurture in 1869.

Galton was a firm believer in the values of mid-Victorian society in Britain – where there was a place for everyone and everyone should stay in their place. The importance of inheritance of each place in society meant that breeding needed to be controlled in what were seen to be the lower social classes to prevent their numbers getting out of hand.

So Galton was the father of the eugenics movement. His book *Hereditary Genius* celebrated the most influential families of his time, where he argued that children would prosper and gain acclaim because they had inherited the necessary talents from their parents. The uneducated, the poor and the feckless would achieve little because they had not inherited these attributes from their parents, and nor could they pass them on to their children. So social mobility was limited by this self-fulfilling prophesy. Galton saw such 'innate' differences as part of Nature. They could not be modified very much by childhood environment and upbringing, in other words by Nurture.

Disagreeable though it is, Galton's distinction between Nature and Nurture is still with us to an extent even today. Some researchers still maintain, based for example on following up the achievements of adopted children compared to those brought up by their biological parents, that the environment of the family home, and even the quality of

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education at school, plays a lesser part than inherited genetic characteristics in determining a child's future. Ideas like this – that who we are is largely based on the genes that we inherited – can even lead to believing that some members of society should not be allowed to conceive a child.

These sorts of societal judgements can have horrifying consequences, for example the 'rescue' of children of unmarried Catholic mothers in Ireland. These girls and women were judged unfit to be mothers even if for reasons of circumstance rather than genetics. Poor care of their children led to many fatalities and their forced adoption to enormous and lifelong trauma. Some of these homes for unmarried mothers and their children were not closed until the 1990s.

Later in this book we'll explain the new scientific reasons for why a hard distinction between Nature and Nurture is biologically incorrect as well as socially dangerous. For now we might remember that nearly a century before Galton, in 1776, Thomas Jefferson wrote in the US Declaration of Independence: 'All men are created equal', sowing the seeds for the human rights movement:

> *… all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the Pursuit of Happiness.*
>
> Thomas Jefferson, US Declaration of Independence in 1776

For us the key to this declaration is that every child should have the opportunity, or in other words be 'nurtured', to fulfil their potential irrespective of their parents and what they may have inherited from them by 'Nature'. Ignoring this principle leads to inequity and social injustice. The word 'created' would have had religious implications in Thomas Jefferson's day. But the 'unalienable Rights' with which we are all 'endowed', we now believe, would include a healthy first 1,000 days, and a supportive society which ensures fairness regardless of how we develop. We'll come back to these ideas later.

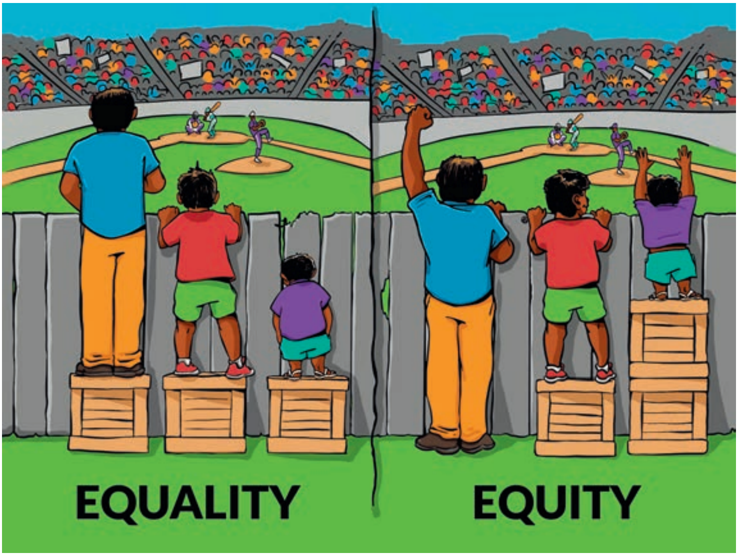

Figure 1.1 Equality or equity? Every child deserves the opportunity to fulfil their potential irrespective of their parents and what they may have inherited from them by 'Nature'. To be fair or equitable, this does not mean giving every child the same, and might require some redistribution of resources.
Interaction Institute for Social Change. Artist: Angus Maguire.

Who Cares for You?

To take the story further, we must think about how the child interacts with the environment and their carers. How much can they really change the child's development?

We can get some idea of just how much from children brought up in extreme or very unusual conditions. Take for example the stories in folklore about children who were reared by animals. The most famous is Mowgli in Rudyard Kipling's *The Jungle Book*, published in 1907. In the story, Mowgli is lost in the jungle in India after his parents are attacked by a tiger and is then brought up by wolf parents. He develops great skill as a hunter and tracker and when he eventually returns to human society he becomes

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a jungle ranger. He is very different from other young men but his time with the wolves had not prevented his development of many human characteristics. The popularity of the first Mowgli story led Kipling to write many others about him. They are imaginative, if far-fetched, but, like many of the best stories, they have some basis in reality.

There are documented cases of children being reared by animals, from monkeys to dogs, bears and goats. In some, a baby only a few months old is adopted by furry parents

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There are in fact quite a few documented cases of children being reared by animals, from monkeys to dogs, bears and goats. In most, the child is left to live with animals after infancy, perhaps around the age of five or older. But in some a baby only a few months old is adopted by its new furry parents. The results seem similar though. When the child is discovered some years later, they are unable to speak, prefer to run around on all fours and have little interest or understanding of human social norms. So distinctly non-human behaviours can develop in a child, for example being wolf-like, without having inherited wolf genes. Unlike Mowgli in Kipling's story though, these children were not easily socialised and had what we would describe as severe behavioural disorders.

Clearer lessons about the importance of our early environment can be learned from children who have been exposed from birth to institutional life in which they were neglected or abused. Some of the most harrowing accounts come from the Romanian 'orphanages'.

In 1966 the hard-line dictator Ceauşescu decreed that contraception and abortion were illegal in Romania, supposedly in an attempt to prevent the country's population falling even more after the effects of the Second World War in reducing it. Abortion was only permitted if the

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woman was over 40 or already had four children. Even rape was not considered to be a sufficient reason for the termination of pregnancy. To enforce compliance with Ceauşescu's unethical plan even further, in 1977 taxation was levied on people who remained childless. As a result, many children were abandoned in so-called orphanages, often because their mothers or parents could not afford to keep them. This became especially true after 1982 when the country's economic situation deteriorated even further. Overall, there may have been as many as half a million children institutionalised.

The conditions in the orphanages were terrible, with little heating or food and low levels of poorly paid, untrained staff who often showed no care for or even abused their little charges. Children were sometimes confined together in cots for days in unsanitary conditions. Needless to say, the emotional damage to these 'orphans' was extreme and both their physical and mental development was delayed. For example, their language skills were very poor.

After the fall of Ceauşescu's regime in the revolution of 1989, conditions in Romania were initially even worse for a time. But by the 1990s and early 2000s programmes to adopt some of the Romanian children to homes overseas were underway. Not all these adoptees went to good homes, unfortunately, but those who were lucky were usually able to catch up in terms of language and mental development.

The ability to catch up was greater in those children adopted before the age of two – the end of their first 1,000 days – than in children adopted at an older age. Research has shown that this was not because the younger children had been exposed to a shorter period of abuse, although this of course would be true, but because rescuing them before their first 1,000 days were over gave greater opportunities to get their development back on track, to learn new skills such as language. It's much easier to influence our development during the period when it's still very plastic.

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Figure 1.2 Children in an orphanage in Romania The conditions and disruption to young children's lives affected both their physical and mental development.
BSIP/Universal Images Group/Getty Images.

Just as with a plastic spoon, plasticity has limits. Bend it a little and the spoon may return to its original shape; bend it some more and it may break or stay bent

This idea of plasticity – the potential to change and to develop in different ways – has been probably understood since the beginning of time, even if it wasn't formally recorded. But just as with an object such as a spoon which is made of plastic, plasticity has limits. Bend it a little and the spoon may return to its original shape; bend it some more and it may break or stay bent. Our plasticity during development is limited in a similar way, because an extreme stress may be just too damaging to allow recovery. But there is another aspect which is at least as important, and this is that developmental plasticity is time-limited.

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Once the period during which it is possible to change and adapt has passed, the opportunity to be plastic is no longer there. So preventing children from experiencing severe deprivation before the first 1,000 days is key to avoiding more damaging and irreversible consequences. This was something which we can learn from the horrors of the Romanian orphanages.

Making up later for a poor start to life can be very difficult. Anyone who has managed to achieve what is called social mobility – the achievement of better socio-economic position even after a poor start to life – will know this very well. We are reminded of the work of Frederick Douglass, born into slavery on a plantation in Maryland in about 1818. After he managed to escape many years later, he became actively involved in writing and speaking out about the evils of slavery and the case for its abolition. In 1855 he wrote: 'It is easier to build strong children than to mend broken men'. This is something that politicians and those who exercise power everywhere should remember. Whether through education or other measures to assist disadvantaged members of the population, investment in early life may not be easy, but the consequences of not doing so are even more difficult to fix.

Parrot Fashion

One of the things which is clear from the Mowgli stories and the horrifying experiences of the Romanian orphans is that the development of language is very plastic. Perhaps this is because it is such a powerful tool, so getting it right really matters.

Once the young child starts to speak, they quickly seem to realise this power. They attract the attention of adults and engage them in all sorts of new ways, sometimes making it easier to influence those grown-ups to provide what the child wants.

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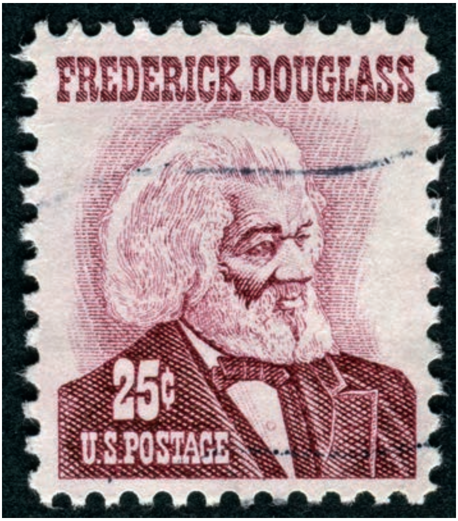

Figure 1.3 Frederick Douglass (1818–1895)
A powerful campaigner for the abolition of slavery, based on his own personal experience.
Traveler1116/Getty Images.

Some children seem to go through a difficult phase, with temper tantrums which are a cause of concern to their parents, before they acquire much in the way of speech, as if they are rather frustrated with their inability to communicate. But from around 18 months of age, the child seems to pick up and use new words on a daily basis. This will be well-received by parents or carers – after all it's much easier to get along with someone who can explain their needs and feelings in words – and so this reinforces learning mechanisms which work fast to memorise and retrieve useful words.

Parents are naturally delighted to hear their child's first word or phrase. Will it be 'computer' or 'picture'? Will it be a word that has been linked to an action like 'clap'?

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Or will it be an embarrassing word picked up by hearing something they shouldn't have heard, in parrot fashion? In truth the child's first word is likely not to have a great deal of significance in the long term and will soon be followed by others with different connotations. All children will try out new words at first, to see if they get the expected reaction and were the right ones to say. It takes practice. This emphasises just how important it is to talk to children from an early age, even though they may not seem to understand and certainly won't reply. They take on board much more than we realise and store the information away for future use.

Is language acquisition a specifically human characteristic? Perhaps it is, because although many other species have the ability to communicate by making sounds in various ways, from woodpeckers pecking to the high frequency calls of bats and the low frequency calls of whales, only the unique structure of the human mouth, tongue and voice-box or larynx allows our complex language communication. But that alone does not explain how, at a certain age, a child starts to speak to their parents in a language which they understand – Spanish, Cantonese, Finnish, whatever. Nor does the genetic basis for the structure and function of the human larynx explain how we partly acquire language from seeing written words as well as hearing them and trying to pronounce them.

The usefulness of language acquisition, even the need for language perhaps, could be genetically encoded and inherited by us all in a reliable way, but the process and the end result are clearly different. So the child growing up in a Greek-speaking family does not start to speak Dutch.

Learning on the Job

We learn much of how to behave as humans on the job, so to speak.

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The key here is the word 'learn'. This is an aspect of our development which we see easily but, unlike our purely genetic inherited characteristics, there is no simple explanation of the process of learning. It must be sufficiently complex to accommodate all the possibilities of human experience and behaviour – maybe growing up in the arctic and learning how to survive the winter by catching fish through holes in the ice, or how safely you can cross a busy city street.

The possibilities are endless, but we only keep those behaviours and ideas that we learn are important, at least to the person we are becoming and the world in which we find ourselves.

We all experience sometimes the sensation of being overwhelmed with information. On a good day, we can summon up skills we've learned to deal with this overload, to filter the information, prioritise what we will pay attention to and incorporate this into our actions. But imagine the brain of a young child. Through their eyes, ears and sense of touch, taste and smell, millions of items of information about the world are being sent to their brain every second. They can't all be stored or even processed.

How does the young child make sense of it all? How can they decide what matters?

The challenge is made even more acute because time is limited, so the young child has to be a quick learner. As many as 50% of the neurons in the baby's brain at birth have shrunk to be inoperative by the time that they become adult. This process is fastest in the young child but is probably not complete until early adulthood. The neurons shrink because they did not make helpful, or much-used, connections. In addition, the neurons that remain – and there are still about 86 billion of them – have pruned down the number of connections which they make with each other, selecting only those that they use.

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When you set up a new mobile phone you know that you could connect it to any of the 3.5 billion other phone users in the world. Your phone is potentially connected to all of them. But you decide to store only a tiny fraction of these potential phone numbers, perhaps a hundred at the most, in your contacts list. These belong to the people whom you regularly contact or need to access easily. So you have made a choice about which numbers to store.

In just the same way, the developing brain 'chooses' to keep the connections between neurons which are operative and useful, and to delete the rest. The key is that those neurons which talk to one another through their nerve fibres and tiny connections (called synapses) stay connected.

In addition, the neurons 'talk' to one another based on experience. In our infancy we very quickly learn to recognise the faces and the voices of the people whom we see most often and who are most significant to us, usually our parents or carers and our siblings. As these people are felt to be important, the neurons processing this information will get good at talking to each other to allow rapid recognition of these faces and voices.

Tuning of the connections in our brains, based on experience, depends on how common a particular experience is, such as how often we see a particular face or hear a particular voice

So the tuning of the connections in our brains, based on experience, depends on how common a particular experience is, such as how often we see a particular face or hear a particular voice. It will also depend on how powerful a stimulus is, for example the strong feeling of contentment when someone feeds us if we are hungry. Equally, a very frightening or painful experience is likely to preserve the neuronal circuitry we used to experience it, even if it only occurred once. Even a young child who touches a very hot stove is unlikely to do so again.

All this tuning of the neurons in our brains – the developmental plasticity we noted earlier– goes on automatically in each of us. It does not involve any conscious control, at least by the young 'self'.

Many of the components of our bodies can be fine-tuned like this during their development, according to what we are experiencing. It might be refining the number of individual cells that make up an organ or the functional control settings of these cells.

We'll all have different experiences in our early lives and so developmental plasticity provides lots of room for individuality. We all grow differently and grow up to be individuals. Some of this development we see played out before our eyes, like behaviour, and some happens out of sight inside our bodies, such as how many muscle cells we develop in our hearts, as we'll discuss later.

We often think of this individuality in terms of the 'personality' which a child develops. This is clearly a gradual process, and in many ways it may not be finalised until the complete maturation of the so-called higher executive functions of the brain which control decision-making, a sense of responsibility etc. New brain imaging techniques have shown that this isn't complete until we are in our late twenties. Perhaps only then is personality finally set in our lives – or perhaps it's never set. But much of what makes each of us a unique person takes place over our first 1,000 days.

Even young babies show differences in personality, for example in their responses to a new stimulus or experience. Some find a new object or a new face interesting, others find it disturbing, and still others seem to treat it with equanimity. These different responses will, in time, evoke a range of reactions from adults, which in turn may inhibit or enhance them in the child, and so the process of developing into a unique individual goes on.

This is all part of the learning process, and again emphasises the importance of stimulating and interacting with the child in a reassuring way in order to reinforce reciprocal interaction and socialisation. We evolved to be a highly social species, and the sooner we learn the importance of social skills the better. Many parents find that young children will become demanding just at the time that they start browsing social media on their phone, or settle to watch a favourite TV programme. The child soon detects that the adult isn't paying attention to them and attempts to change the situation. In addition, new research using monitoring of brain function is revealing that young children who spend several hours a day on screen-based activities – whether on a computer or watching TV – show altered executive functions which are likely to make them find it hard to focus and concentrate on tasks when they later attend school. This is a rapidly moving field of research and is likely to have important implications for childcare.

A mother of a two-year-old was puzzled that he seemed to wave his hand back and forth whenever she reprimanded him for naughtiness, that is, until she realised this was what he had learned to do on an iPad in order to change what he saw

What the child learns early isn't necessarily what parents or carers, or indeed society in general, will see as acceptable social behaviour. A mother of a two-year-old was puzzled that he seemed to wave his hand back and forth whenever she reprimanded him for naughtiness, that is, until she realised this was what he had learned to do on an iPad in order to change what he saw – if she seems cross just swipe her away!

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Tickling the Senses

For a child to learn things about the world there are some basics that need to be in place. These include structural components of the body. Making them is in essence driven by the genes we inherit from our parents. Then comes the process of checking the way that these basics are working against rules laid down in the society and environment where we live, and against our past experiences. This learning process applies across all our body's cells, organs and systems. Having rules makes such learning less complicated than it might seem.

One visual shortcut is in detecting edges and outlines of objects, and this may also explain the odd fear that cats have of cucumbers – a case of mistaken identity based on a snake-like outline perhaps?

Take for example sight – our visual system. The visual system is extraordinary in its precision. But it also has useful shortcuts to save time and simplify the visual processing required. One way is in detecting edges and the outlines of objects, helpful for example for speedy recognition of a symbol on a road sign while driving. Maybe it also explains the odd fear that cats have of cucumbers – a case of mistaken identity based on a snake-like outline perhaps?

Detecting movement is another shortcut our visual system uses to speed up the detection of critical aspects of the visual world. Many animals are much better at this than we are, especially predators like cats. But even in the young child, the processing of sensory information by the brain must be very clever if the child is to make sense of their world. Imagine the child sitting comfortably in their chair when their brain detects that a favourite soft toy is moving. This is a surprise, but something is happening because the toy is moving across the child's visual field.

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Now the brain has to decide whether the toy is actually moving. Maybe it just appears to be moving because the child's eyes have moved, or their head has swivelled or their body has shifted sideways. We can scarcely imagine the complexity of the brain's software which allows it to use all the inputs from the retina, the muscles attached to the eyeball and those in the neck and body, to decide what has happened and which of these possibilities is correct. Within much less than a second the child's brain has figured all this out, and the child shows surprise or delight, or simply ignores the information.

Some fundamental anatomical properties of our eyes are basically fixed and can't be changed. But the visual system takes a while to develop its full function and, while it's developing, it's learning from experience, rather like machine-learning in a computer artificial intelligence program. In some experiments in psychology many years ago, researchers raised kittens in environments which featured predominantly horizontal or vertical lines. When the cats were adult, their visual systems were found to respond largely to images containing either horizontal or vertical lines.

Although it takes some time for the lens of the baby's eye to take up the appropriate shape in order to focus on objects, it can initially see those which are fairly close to the face. The rod receptors in the retina which detect levels of light, and the three types of cone receptors which detect ranges of colours in our visual range, are functional at birth.

The nerve fibres from the retina which send visual information to the processing neurons in the brain are there too. They will eventually connect to columns of cells in the outer layers of the brain to make a map of the visual world, rather like the pixels of a digital camera image. The process of making these cell columns takes time and is based on experience over that time. Once formed, their connections and the aspects of the visual world to which they respond cannot be altered.

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Animals differ in the extent to which their visual processing systems are developed at birth. The newborn lamb obviously has a much more mature processing capability than the human infant. Unlike many other newborn animals which can take time to develop in the safety of the nest, the lamb quickly has to fend for itself. Not only can the lamb walk around within a few minutes of being born, even if rather wobbly, but it has to find its own way to the mother's teat which will supply its first meal. It can soon navigate obstacles such as rocks or trees and even has a good three-dimensional sense of depth, which will be useful if it's been born on a steep hillside.

We humans are way behind this at birth. Very similar processes to vision operate for the baby's other sensory systems – hearing, smell, taste and touch. All these senses feed into a map on the surface of the brain with an area of the map to do with vision, and areas for the other senses. For the skin, the receptors for light touch, deep pressure, heat, cold and pain for large areas of the body feed into parts of the mapping area. In the newborn baby the map is diffuse and not well focussed. With experience and time, the mapping becomes more accurate and detailed.

In early life the baby may not be able to discriminate between stimuli such as touch, pain, hot and cold over much of the arms or legs. As the focussing proceeds however, the discrimination becomes much finer, extending down to the fingers and toes until eventually the very accurate sensory perception we have, especially in our fingers, is achieved. This is made possible by the much greater number of sensory receptors in the skin of our fingers than, say, our backs. So the size of the area of the brain associated with sensory perception in the different parts of our body depends on the number of receptors and their importance in our lives. The face, and particularly the lips, has large representation, as do the fingers and toes, while the torso has much less.

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Figure 1.4 Exploring the world around us The development of the child's responses to the world critically depends on interaction with their environment – testing the limits of things in their path, sensing with their whole body. This is happening in plain sight after birth. But it does not require expensive toys or games. It's the everyday world they need to explore.
Dean Mitchell/Getty Images.

We've now arrived at a really important point in our story, which is that the development of the child's responses to the world critically depends on interaction with the environment. And this makes the possibilities for individuality endless. Making a person is a lot more varied and interesting than genes and inherited 'nature'.

Just Checking

One of the essential aspects of the child's development, as with any learning process, is checking. If you're learning a language, and your teacher uses a new word which you haven't heard before, you will try to repeat it and check that

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your pronunciation is good enough and that you're using it in the right context.

Watch a child who is doing something that they are fairly sure is naughty – they may look around questioningly to check the response they get. The same is true of good behaviour – it's as if they're thinking 'Did you see that? Aren't I good … Where's my reward?'

This sounds rather as if the child is exploiting the relationship with their carers, but really it is no more than comparing the experience which results (punishment or reward, a frown and a sharp word or a smile and encouraging words) against a prediction.

And what is true of this relatively conscious behaviour is also true of the child's nervous system as a whole. As with the process of detecting key features of the environment such as edges, changes in colour and movement, which speed up processing and learning, the brain operates by comparing experience to new events, predictions to what actually happens.

When you are about to get under the shower, you have a whole set of predictions about how it will feel based on past experience. You will usually concentrate on just one aspect of the barrage of sensory input that will result – is the water temperature right? This is the most important thing if you're not to get burnt or hit by a cold shock that will be very unpleasant. If you had to discriminate the temperature changes consciously, by processing all the other sensory input about the shower, it might take several minutes.

Taking a shower isn't usually a life-threatening exercise (aside from some classic horror movie scenes), but avoiding an approaching bus as we are crossing the road is critical. We have to be able to act fast to recognise that this is a bus and that it is coming towards us, without taking time to consider the situation.

By the end of the first 1,000 days of life, the child has usually developed some quite complex aspects of perception

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and behaviour. To a degree, they have understood what psychologists call the 'theory of mind'. This simply means that, while you may be feeling and thinking something – perhaps how boring the company of a particular person is right now – other people not only have thoughts and feelings of their own but they may be aware of yours as well. So it may not be in your best interest to show how bored you are, as it may just provoke anger which may make the situation worse.

As we get older, we can't function well as social beings without unconscious use of this theory of mind. The extent to which it is fundamental to a person's behaviour, and how strong their unconscious sense of this theory is, varies. In individuals with Asperger's syndrome for example it seems to be weaker and they may seem to find some social interactions difficult or they may behave inappropriately. This isn't necessarily a problem, especially once it has been recognised, because it is often counterbalanced by other skills and attributes.

Self-Control

Some aspects of self-control are conscious, and some happen whether we like it or not. What is becoming clear is that, like other aspects of brain function, self-control is set up in response to the world around us and starts in each of us before we are two years old.

The fact that it develops early in life suggests that a sense of self-control is important for the growing child. This is obviously important from a purely physical point of view, if toilet training is to be successful for example. The child has to learn that they must get to the toilet in good time.

Perhaps in fact, the development of a sense of time and of continuity underlies self-control more generally. If the child does not understand that a favourite food will still be there in a few minutes time, perhaps when other family

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members have had a chance to join the table, why not grab it now? And while having antiseptic cream and a plaster applied to a cut may make the cut hurt even more right now, there is no point in screaming and fighting because it will feel better in a few minutes.

Psychologists have been able to show that even young children can exercise self-control to a degree. For example, they can delay eating a treat for some time in order to get a bigger treat later. So self-control is already linked to a sense of time and to the consequences which an action now may have later. This is similar to the 'if-then' syntax (code) which is fundamental to computer programs. Parents or carers use this format without thinking: 'If you do that again, then I will take the toy away' or 'If you eat this vegetable up, then you can have your sweet'.

Put together with the sense of the theory of mind, we can see how human social interactions develop: 'If I do that, then mummy will be cross. She'll be cross because she knows that I know I shouldn't do it'.

Will the child improve their behaviour as a result of understanding 'cause and effect', or decide to be deliberately naughty? Time and experience will tell

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Behind this scenario lies a sense of cause and effect.

Will the child improve their behaviour as a result of understanding 'cause and effect', or decide to be deliberately naughty? Time and experience will tell.

This process of learning from our experience also operates for the motor, or movement controlling aspects of the brain. Drinking from a cup is a perilous business for a small child. But as adults, when we pick up a cup of hot coffee, we have (unconsciously) an idea of what it will weigh and where to hold it. As our fingers close around

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the handle, we predict that it will feel just like a handle; then the muscles of the arm contract to raise the cup in a smooth motion in three dimensions towards our lips. We will sip very cautiously at first and put the cup down if it's too hot or doesn't taste right.

Drinking coffee would be agonisingly slow if we had to consciously judge the weight of the cup, the need to keep it upright and the need to move it in three dimensions. The growing child's brain has to learn all this, from the important aspects of the sensory world to focus on, to the amount of force needed and the control necessary to carry out an action.

For adults, the developmental progress of a baby over the first two years can sometimes seem agonisingly slow. A new parent might long for the time when their child's bladder is under control, or the first steps are taken, or the first drink is taken from that cup. It can be frustrating waiting for these accomplishments to develop and hard to tell ourselves that most kids won't wear a nappy for life, will eventually walk and won't keep drinking from a baby bottle as an adult.

The good news is that usually this frustration is forgotten – when we ask older parents how long it took before their child, now grown up, could eat from a spoon unaided, for example, they usually can't remember.

But even so we can't resist the temptation of trying to accelerate the progress. We don't expect a young child to drink from a glass, but we assess how their sensory perception and motor control develop in order to decide what is appropriate – moving perhaps from a plastic trainer cup with a secure lid, to a small beaker and eventually to a glass itself. This is all part of the interaction process. As the child learns new skills, the kind of support they need changes too. What does not change is the need for positive encouragement.

Square Eyes

There's much interest, but also considerable concern, about the effects of the digital world on the development of young children. As with other aspects of their learning, in the first two years of life today's children learn very fast to use touch screens, a computer mouse and even a keyboard.

Devices and functions which are alien and hard to understand for older people are mastered effortlessly by young children. They seem to use them 'naturally'. This is to be expected: it's their world and they haven't known anything different. But as their brains learn quickly to use smartphones and laptops, we may wonder what the longer-term effects on their bodies and their brains will be.

Some effects are unsurprising. Children who spend hours playing computer games or just watching TV rather than engaging in physical activities are more likely to become overweight. And the light emitted by some tablets and laptops can stimulate the brain's system for distinguishing night from day and make it harder to get them to sleep at bedtime. But are there longer-term effects? We just don't know.

Some researchers think that the use of touch screens, which requires quite delicate, accurately controlled movements, will speed up and improve the development of hand–eye coordination. So will today's children grow up to be better at graphic art or tennis?

Others worry that a shift away from three-dimensional and conceptual skill development, such as the pastimes of their grandparents when they were children – gluing models together, needlework or domestic science – will delay or reduce acquisition of other aspects of fine movement control. So will today's children be unable to become brain surgeons?

But over one aspect of this brave new world all child development experts are agreed.

The potential exposure of even young children to graphic images, from violence to pornography, on the internet is a real danger. So is the risk of grooming by predators on social media. We clearly have to find effective ways of protecting children from these aspects of the digital world, and we also have to develop ways to educate them from an early age about such risks and about how to detect them and defend themselves.

Learning to Protect Yourself

We watch and marvel at how young children develop skills based on experience of the world, but there are many aspects of this which we can't see. The whole body is engaged in it – the growing cells, organs and systems. One which we increasingly realise to be very important is the immune system. This has to defend the body against foreign invaders, such as bacteria or viruses, throughout life. It does this by producing the body's equivalent of a missile defence system, antibodies which bind to the invaders and signal to special killer cells that they have found such invaders.

Like the visual system, the immune system has to refine its activities to be efficient. It can't just attach killer cells in the body without good reason. So it has to learn how to recognise something as foreign, to distinguish between 'self' and 'non-self'. To a certain extent, as with the visual system, this is an inborn property of the immune system but, as with the visual system it also depends on learning from experience.

For the fetus, in the relatively germ-free environment of the womb there isn't much opportunity to experience or learn about 'non-self', so really the learning exercise is largely around recognition of 'self'. The fetus in the womb is developing the thymus gland at the base of the neck which produces the immune cells. After birth the immune cells are produced by the bone marrow and the thymus has a smaller role. Life after birth is full of germs, and now the immune system will have to learn about a much wider range of targets.

So the baby is born with a degree of 'innate' immunity. The cells which are ready to detect foreign invaders ignore the other cells in the baby's blood, even though they are characterised by a particular blood group and would, if present in the bloodstream of a baby with a different blood group, produce an intense and very dangerous reaction.

From now on, the baby has to acquire the immunity on which its life may depend. When it meets invaders, for example the viruses which produce the common cold or COVID-19, its immune system gears up to tackle them by making antibodies to the virus and activating the killer cells. This usually takes several days, after which the infection begins to subside. Then the infant feels better, except that, just as in the adult, the viral infection is usually followed by a bacterial infection which makes pus in the nose and throat and could lead to a chest infection.

As doctors have learned during the pandemic, infection with COVID-19 can lead to a viral pneumonia which can be very dangerous. However, for reasons which have not yet been explained, the really dangerous consequences of COVID-19 infection are rare in young children.

Once exposed, the immune system has learned a strategy for dealing with a particular virus, and this is why when a nasty cold is circulating the infant won't catch it twice. When the virus invades again, the immune system is ready for it and will remember this virus pretty much for the rest of life. It is so effective that for some invaders, such as the measles virus, the immunity from future infection is complete.

We can induce this immunity by giving a weakened strain of the virus or bacteria to the child, by vaccination. This is now standard practice for the triple vaccine, MMR (mumps, measles and rubella). It is really important that all children receive this vaccine so that the population as a whole is immune to these dangerous and sometimes deadly organisms. This is the idea of 'herd immunity' which has been discussed repeatedly during the COVID-19 pandemic.

There were scare stories some years ago about the potentially harmful effects on the child's brain development from the MMR vaccination. They were unfounded but, sadly, some parents feel that they would rather not take the risk for their child. This isn't just being cautious – it's actually dangerous for them and their community. The unvaccinated child may catch measles, mumps or rubella and the diseases can spread very quickly throughout the population. The infections can be fatal in elderly people, affect male fertility and can produce deafness in a baby if a woman catches it while she is pregnant. We may not like to think of ourselves as part of a herd, but the reality is that no-one is safe until everyone is safe, so achieving and maintaining herd immunity can be argued to be everyone's duty.

The reason why these diseases don't make national news every day is because they are now rare. And they are rare because in most developed countries we have a high level of herd immunity because almost everyone is vaccinated. In some communities where the vaccination rate has dropped, we are now beginning to see these diseases becoming part of life, just as they were 100 years ago in the UK. In addition to this, our increased travel, destruction of wild environments and increased contact with wild animal species is leading to epidemics of diseases transmitted from animals to humans. They include AIDS, SARS, MERS, Zika and of course COVID-19 which at the time of writing has already infected more than 250 million people and caused the premature death of more than five million people globally.

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There is another aspect of the environment about which the baby's immune system is also learning. Some components of that environment can produce a violent allergic reaction in some of us. We probably all know someone who is allergic to nuts, or eggs, or to certain pets. And conditions like asthma can be very distressing and even life-threatening in some people. Breathing problems like this can be triggered by house dust, which contains mites whose droppings the body recognises as foreign. Some of these allergies are increasingly common, and research shows that part of the problem is that many children are brought up in much cleaner environments than they were before – no dust, no animal hairs and certainly no animal droppings.

When we think of the conditions to which children were exposed even 100 years ago – in dusty and dirty urban environments for example or on farms in rural areas, the places where they played and even their schools – we can imagine that they were exposed to a barrage of potential pathogens. Of course, many childhood infectious diseases occurred as a result, and sadly childhood mortality was high. In 1920 nearly a third of the world's children died before they reached the age of five years.

But on the other hand, allergies and asthma were much less common. The immune systems of these children learned early in their lives to recognise these dirty aspects of the environment and to prepare defences against them.

Today, 'dirt' can come as a surprise to our children's bodies and produce an excessive reaction. No-one is suggesting living in squalor, but perhaps it doesn't make sense to be too clean? It is interesting that similar immune system reactions can happen to food and the current advice to parents and carers is to expose babies from about four to six months to some potential allergens such as peanuts or eggs. The baby, of course, isn't old enough to eat these things, and giving them whole nuts would pose a very dangerous risk of choking, but the amounts needed to help the immune system to learn are really very tiny.

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Figure 1.5 Children playing in dirty conditions in the 1960s
The immune systems of children learn from exposure to their environment and prepare defences. In current times, 'dirt' can come as a surprise to our children's bodies and produce an excessive reaction.
Mirrorpix/Getty Images.

One of the reasons why breastfeeding is recommended whenever possible is that breast milk contains some of the antibodies which the baby needs to protect itself. Getting this ready-made supply can also help to protect against infections at a time when the baby's immune system has not learned to recognise invaders. The other reason of course is that breast milk contains the complete set of nutrients that the baby needs.

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Gut Instinct

Before we leave the immune system, there is another aspect of the foreign environment which we need to highlight. The environment in which we live isn't only outside us – it is inside our bodies too. From the mouth to the anus, our digestive systems are in fact part of the external world, basically a tube passing through us. The food we eat does not instantly become part of us – it remains in this tube while it is digested and only then are some of its constituents such as sugars, protein components and fats, absorbed into our bloodstream.

Our digestive system, the part of the external world which we carry around in us all the time, is populated by bacteria. There are in fact more bacteria in our guts than there are cells in the rest of our bodies, so we might say that we're really just walking homes for them. Fortunately, these bacteria are almost all useful to us. They help to digest our food, crowd our guts making it harder for other invaders to get a foothold, and can also influence our immune responses. Every day we pass billions of them out in our faeces, only for new members of this internal colony to breed and replace them.

Our 'microbiome', as this internal world of bacteria is called, is unique to each of us in some respects. We have literally inherited some members of it at birth, when we are inevitably exposed to our mother's body. We pick up some founder members of our gut microbiome at this time and they start to colonise the gut. Babies born by caesarean section will have a slightly different microbiome from those who are born vaginally for this reason, as will babies born to mothers who have recently taken a course of antibiotics. We'll return to the issue of delivering a baby and interventions like caesarean sections in Chapter 2.

Research on the microbiome is one of the most active and exciting areas in biology and medicine, and no doubt new discoveries about how 'friendly' bacteria affect our lives will soon be discovered. As we grow and develop, and learn about our world, the populations of bacteria within us are changing – learning too in a way – and these bacteria are going to influence how we respond to many aspects of our lives including the food we eat.

The End of the Beginning

As parents, as we look back on the time up to the child's second birthday, we often realise that many of our worries about the baby's development during that time were unfounded.

Probably the most common concern of parents or carers is about whether the infant is growing well. Much time and effort are spent on weighing infants and plotting their growth on a chart to see how well it conforms to that expected, on the basis of data for the population as a whole. It is true that the babies who struggle with their health and wellbeing during infancy are the babies who aren't growing well. Poor growth is a marker of problems, but growth charts also cause a good deal of unnecessary anxiety.

We also worry about babies who are growing rather too fast for the population graph, because they're often becoming too fat. We know that the risk of obesity in childhood, and then in teenagers and adults, can start in the first 1,000 days of life, and this is something we'll return to later in the book.

Some things come naturally to the baby, and in many ways, they are far more in control of their lives than we might think

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Some things come naturally to the baby, and in many ways, they are far more in control of their lives than we might think.

One of the great advantages of breastfeeding is that it is impossible to overfeed the baby. The baby will detach from the nipple when they've had enough, and breast milk contains the perfect combination of nutrients. Some infant formulas can provide too much nutrition, which may not always be balanced, and it is too easy to overfeed an infant by using a bottle.

But society does not always make it easy for the nature of the baby to exert itself. Support for breastfeeding, for example by providing clean safe rooms for women who wish to feed their babies when they are outside the home, are not available in many places, whether public or private. As well, there are many experiences of a healthcare system which is under-resourced to provide the breastfeeding support that is needed. Many women talk of the pressure put on them to breastfeed, while sometimes this isn't possible for many reasons, leading to feelings of guilt or failure as mothers.

But in the next phase of the infant's feeding even more potential problems are encountered. Weaning is a time for more decisions and influence by parents with the introduction of solid foods. It's a time when the baby needs more robust sources of food, and when they can start to experience new flavours and textures. It is also a time when an unhealthy diet can increase the risk of the child becoming overweight or obese. Parents need support, because some weaning foods can be unbalanced in nutritional terms and provide excessive calories.

JM Barrie once said: 'You always know after you are two. Two is the beginning of the end'. *He might have been reading this book*

So the moment-to-moment response of body and behaviour to the environment of a child, and the learning that takes place, will influence that child's development.

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We may not be able to recall anything about our first two years, but our bodies and brains have in-built memories which will shape our future lives. This was appreciated by the author JM Barrie, who created the character Peter Pan, the boy who could fly and who inspired many other children's entertainments such as pantomimes. But Peter Pan never grew up in the stories. There is a clinical condition, called Peter Pan syndrome, which describes adults who want to remain infantile.

Barrie once said: 'You always know after you are two. Two is the beginning of the end'. He might have been reading this book – and discovered how important our first two years are.

But JM Barrie's idea is somewhat fatalistic – as if the game was over at the age of two. We disagree, and believe that an optimistic view is nearer the truth. We would say that age two in many ways marks the *end of the beginning* of making a person, the phase when what our bodies and our brains have 'learned' sets the course for our best chances in life. So, as we are telling the story of our development backwards, we need to go back further in time if we are to understand that beginning. We need to think about our lives in the womb. And that immediately faces us with one of the greatest challenges we meet in the whole of our lives – being born.

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