

THE LAUGHING BABY

"An easy, fun read! Loved it."
—Dr Howard Chilton

Peekaboo: discover why this game is the ultimate in baby laughter

Tickling: understand an amusement that is millions of years old.



Eureka: learn how babies delight in discovering the world.

■ The Extraordinary Science Behind

■ What Makes Babies Happy

■ CASPAR ADDYMAN

THE LAUGHING BABY

The extraordinary science behind
what makes babies happy

CASPAR ADDYMAN

 booktopia
editions

Contents

Introduction: What's So Funny?	I
Chapter One: A Time Before Smiles	7
Chapter Two: Happy Birthday	24
Chapter Three: The Simple Pleasures	47
Chapter Four: SLEEP!?	70
Chapter Five: First Touch	100
Chapter Six: Tickling, Tumbling and Toe-Nibbling	116
Chapter Seven: The Joys of Toys	149
Chapter Eight: Surprise!	183
Chapter Nine: Laugh and the World Laughs with You	218
Chapter Ten: The Sound of Happy	259
Chapter Eleven: Happy Talk	290
Chapter Twelve: Yes, No, Maybe, Baby	317
Chapter Thirteen: Friends	344
Epilogue: Laughing Matters	373
References	379
Credits	405
Index	407
A Note on the Author	417

Introduction: What's So Funny?

Babies are such a nice way to start people.

— Don Herold, American humorist (1889–1966)

*What a piece of work is a man! How noble in reason, how
infinite in faculty! In form and moving how express and
admirable! In action how like an Angel, in apprehension how
like a god! The beauty of the world! The paragon of animals!*

— William Shakespeare, *Hamlet*, c.1600, Act II, Scene 2

Even the morbid Prince of Denmark had to admit humans are a big deal. Thanks to Charles Darwin, we no longer think of ourselves as the single summit of evolution. We're one tiny twig in the tangled thicket of life. We occupy a niche as social, bipedal omnivores. Glance around the planet and we have many well-adapted cohabitants, each excellent at their own tricks. Eagles and sharks outhunt us. Cheetahs and even hippos can outspurt us. Elephants and whales outlive us. Ants outweigh us. Plants and amphibians have bigger genomes. And bacteria secretly rule the world. But no creature is as clever, as dexterous, as social, as collaborative or as emotional, let alone

THE LAUGHING BABY

as artistic, as talkative or as musical as humans. We are amazing and yet we are born almost entirely helpless.

Every superhero has their origin story: Superman and Batman were orphans, Spider-Man and the Hulk went radioactive. As you will see from this book, babies are the origin story of our own superpowers. If human babies were not so helpless, we would not be so clever. If our babies did not need our support, humans would not be so social. Our connection to our offspring even gives rise to our creation of music and art. We are all superpowered and the first two years of life are our training montage. This is a feel-good film.

Babies are pure joy and this book celebrates their achievements and their delight. The two are closely connected. Babies work very hard in their first two years, but to them it feels like play. They learn a lot and they laugh a lot. Curiosity and glee drive them forward. Surprising discoveries and daily progress keep them going. Parents provide support and encouragement – meeting babies' basic needs and structuring their lives. But it is the babies who scale the mountains and stand triumphant at the peaks.

So, this book won't list the dos and don'ts of raising a superhero. It is not a parenting manual filled with advice or warnings – I am not a parent. It is a book about the science of being a baby. As a developmental psychologist I am interested in the baby's perspective. I want to know what they are thinking, how they are learning and why they have so much fun along the way. Being a baby is a great adventure, full of ups and downs. Parenting books help you avoid the downs, but I believe there's a lot to be learned from the ups too.

What's So Funny?

I have been a baby scientist since 2005, but it was only in 2012 that I started taking baby laughter seriously. My younger sister had just had her second baby and my younger brother was stand-up comedian. I was wondering what we could all do together. Eureka! Max could make the new baby laugh and I could explain why. It turns out that stand-up comedians take laughter quite seriously, so Max thought the gig was too easy. But the idea was planted in my mind and I started to wonder if baby laughter was a suitable topic to study.

I discovered very little previous research. Laughter is spontaneous, which makes it tricky to study in a laboratory. This is especially true of babies: they may laugh often, but they can be enigmatic, laughing at the most unexpected things. Stand-up comedy for babies is harder than you might think. Few scientists had taken on the challenge of studying laughter, which was usually viewed as a marker for something else, such as a way to understand early humour and joking, or as an indication of a baby's temperament and positive mood. Rarely was laughter central to the story of development itself.

Laughter is abundant in babies' daily lives and universally appealing to everyone else. I felt it must be important. I created a website (laughingbaby.info) and designed a detailed survey of baby laughter. Journalists from all over the world covered the project and thousands of parents from dozens of countries completed my questionnaire. Hundreds more sent me short 'field reports' and videos of things that made their babies laugh. I started to take baby laughter very seriously indeed.

THE LAUGHING BABY

In the years since then I have concluded that my intuition was broadly correct. Laughter is important to our early development and the roots of laughter are planted deep by evolution. This does not mean babies who laugh more develop better. There is no recommended daily amount of laughter. Instead, think of laughter as a happy counterpoint to crying. When a baby cries, we do not focus on the crying itself: we stop what we are doing and try to fix the problem the baby is telling us about. Laughter is the opposite; it is a baby sharing its successes. I believe it is worth stopping to examine those triumphs. In fact, this may be the purpose of laughter.

As I studied laughter, my interests kept widening to consider all the ways babies thrive and how they strive to meet their wider goals. So this book is about babies' emotions, their connections, their learning and their curiosity. It covers the first two years of life in roughly chronological order, but I have avoided putting in too many milestones. They don't mean much. Each baby follows their own path. The book is about the journey not the destination.

We have plenty of growing and learning to do beyond the first two years. But the foundations we build are important. Studying our origins helps us understand ourselves better. Don't get fooled into thinking this book is going to be just about the fun and games of babies. It contains a lot of serious academic research, explaining many core concepts that apply far beyond babyhood. We will address such big questions as how the mind works, how we evolved, what emotions are and what art is. Along the way, we will see babies taking on intellectual giants

like René Descartes, Sigmund Freud, Noam Chomsky and Ludwig Wittgenstein.

Ultimately, however, this book is intended to do the impossible, which is to make the adorable sound of a baby's laughter even more enchanting. If it fails, find a baby and let them entertain you instead.

A Note About Scientific References

Throughout the book I try to give credit where credit is due. Science is a collaborative and cumulative exercise. Isaac Newton famously declared in 1675: 'If I have seen further, it is by standing on the shoulders of giants.' Scientific progress happens through evolution. Revolutions in science rarely throw away what came before; more likely they refine it. We argue about the details, but we are all working on the same big picture.

Only a minority of the research in this book is my own and I rarely give more than a summary. It is important to credit the people who did the work and point out where to find the full, original versions. Popular science books often hide this information in footnotes or endnotes, or omit it entirely. I prefer to use the convention adopted by psychology journals. When referring to a study you give the names of the authors and the year of the publication like this: (Author & Author, year). For example, one early work on happy babies was written by Charles Darwin. 'A biographical sketch of an infant' was published in the journal *Mind* in 1877, which would be referred to as (Darwin, 1877). The message is that you can skip over

THE LAUGHING BABY

these. But each time you see a reference like this be aware that those were the people who did the real work. The full title of the work and where it was published is given in the References section at the end of the book.

Likewise, I have avoided footnotes. Scientists are pedantic sorts, always pointing out exceptions, approximations and alternatives. It gets very exhausting for everyone, so I have not done that. (I even try to avoid parentheses.)

Chapter One: A Time Before Smiles

When the first baby laughed for the first time, its laugh broke into a thousand pieces and they all went skipping about and that was beginning of fairies.

— J. M. Barrie, *Peter Pan*, 1904

A baby's first laugh is a magical moment. Parents have no trouble remembering it, even years later. Happening anywhere from a few weeks of age to four or five months, those early laughs will very likely be small and subtle, a light and breathy chuckle. A tiny baby cannot coordinate the rapid contractions of the intercostal chest muscles required to laugh properly, but the sound is unmistakable nonetheless.

For the ancient Greek philosopher Aristotle, the first time we laugh marks the instant when our soul enters our body and the moment we become truly human. He thought laughter was what separated us from the animals. He was wrong, of course. Other animals can and do laugh and the boundary between us and other species is a matter of degree, a question of genes and culture. As for the soul, nowadays we would probably call it 'consciousness' and we understand that it dawns slowly.

THE LAUGHING BABY

A baby's first laugh is a very special event and one that feels transformative. Sometimes it is a spontaneous sound of well-being and satisfaction: 'I am warm and happy and full of mother's milk.' Occasionally it is a response to something the baby sees, like a shadow waving on the wall. Best of all is when it is the result of something a parent does – returning to the room or planting a ticklish kiss. However small the first laugh may be, parents will recognise in it the idea that 'a laugh is a smile that burst'. It is the first time a baby expresses their absolute delight with the world.

It is a memory that can stay with a parent for ever. When I ran a global survey of baby laughter in 2012, one parent, Mary, took the trouble to write and tell me about 'the sound of the angels' that burst forth when she kissed her tiny daughter's tummy. It had happened 42 years previously, but it still echoed in her memory and made her 'smile with JOY'. It was one of many similar stories. This is rather remarkable, given that adult memory is usually very vague and non-specific. What did you have for lunch yesterday or do on your last birthday? Not many events in our grown-up lives stick all that well. Even wedding days become hazy. But our children's first laughs, first steps, first words remain with us and raise a smile decades later. Memories of first smiles can be more elusive and uncertain. Parents have a hard time pinpointing the very first smile and more difficulty recalling it. There are several things happening here. Not only are first smiles more subtle and fleeting but very often parents have been taught to doubt their own judgements.

A Time Before Smiles

There is a much-repeated myth that all smiles before about six weeks old are merely trapped wind or the sign of a baby filling their nappy rather than a true expression of pleasure or contentment. This myth is widespread and persistent. I've even seen it on popular midwifery websites. It is one I completely reject. It is true that babies do pull funny faces when burping or pooping. They also smile with true satisfaction. The parents I've surveyed are convinced they have seen genuine smiles from very early on and I believe them. They are, no doubt, slightly biased, but they are also studying their own baby far more intently than anyone else does. No one doubts that first cries and first tears are real. A baby in distress is obvious to all. Yet, strangely, experts often deny that early positive emotions are valid, saying first smiles aren't 'proper smiles'.

Worse yet, here we have new parents being told by experts they are wrong about something so basic. As they're already uncertain of their own abilities, it is not a great way to reassure them. The key message of this book is that parents and their babies figure most things out for themselves. Nobody is ever properly prepared for a baby. But, equally, parents know more than they realise, and they learn fast. The first weeks of life are even more stressful and bewildering for the baby, but their little laughs and smiles are a sign they are succeeding. No one should take that away from them. Happily, we will find the parents are correct, not the experts, as babies are able to experience and express pleasure before they are even born.

There is another milestone for new mothers that it is often overlooked. When was the first time her baby made her laugh?

THE LAUGHING BABY

This is earlier than you think. Of course there can be big smiles at the very beginning. Perhaps the time when she first suspected she was pregnant. Perhaps when it was confirmed by that second blue line on a pregnancy test? Or maybe a little later, when seeing another mum with her new baby made the reality of her own future more concrete?

Secret Joy

But I am not talking about those moments. I like to think the first time a baby directly makes mother laugh is when she feels it moving inside her. A good friend tells me of laughing on noticing her unborn daughter had the hiccups. But it doesn't take something as comical as this to bring smiles to a mother's lips. Often it is just the joy of a tangible new reality.

In my favourite part of *Expecting*, Chitra Ramaswamy's book-length memoir of her pregnancy, Ramaswamy describes going out for dinner with friends to celebrate her birthday. At five months pregnant she can't enjoy the restaurant's adventurous food, and is distracted from her friends as her baby wriggles inside her.

I sat sipping champagne that tasted more like cider, pretending to follow the conversation while the baby fizzed in my belly. I said nothing about this furtive firework display. I had no desire to talk about it. There was nothing for anyone else to feel, nothing for anyone else to understand. This was my secret Morse code tapping out its message on my insides. I felt flushed with joy. It was one of the happiest moments of my life, one I

can summon up whenever I want to, and often do. (pp. 84–5, *Expecting*, Chitra Ramaswamy, 2016)

Just as that private joy became one of the happiest moments of her life, Ramaswamy also relates how Leo Tolstoy makes this secret moment a pivotal scene in his realist masterpiece, *Anna Karenina*. Anna is pregnant with the child of her lover, Vronsky, but huge obstacles face them because she is already married. Anna has dreamed she will die in childbirth, and informs Vronsky, prompting another a fraught discussion of their doomed affair, but in the middle of this Anna experiences the great fears for her situation giving way to a sense of bliss when she feels her baby stirring inside her.

This first feeling of movement is known as ‘the quickening’. For thousands of years it was the first major event of pregnancy. Before pregnancy tests and modern medicine this was the first time a woman could say with certainty that she was pregnant. Ancient Greeks and Romans thought this was the moment when the soul entered the child’s body. They believed that these movements indicated the moment when the foetus became ‘animated’ with life – *animus* and *anima* being the Latin words for mind and soul respectively and both having their roots in an even more ancient proto-Indo-European word for breath or breathing.

The legal system also recognised the quickening as the point that divided life from potential life, as in the biblical phrase ‘the quick and the dead’. In English common law abortion was permissible before this point, and assaults that caused a

THE LAUGHING BABY

woman to miscarry after the quickening were treated as more serious. Until 1869 even the Catholic Church held this view; it accepted abortion before the quickening as the destruction of potential life, not of life itself. Legal definitions are now based on viability of life outside the womb. English law recognises a foetus as being 'capable of being born alive' from 24 weeks and a baby's legal status as an individual commences from the point they draw their first breath.

In the private history of any individual pregnancy, quickening is a big milestone. The very first flutters of movement are a tangible joy, literally a 'touching' moment. From here onwards a mother has a new connection with her little passenger and can start to infer their personality. Comparing the patterns of activity with the experiences of other mums-to-be, is her little one more prone to wriggling late at night or early in the morning? How do they respond to music or their mother's mood, to coffee or to cake?

For a first-time mum the initial feelings of a baby moving typically occur between weeks 16 and 20 of pregnancy. Second-time mums tend to notice these movements several weeks earlier because their uterus walls are thinner, but foetuses are moving long before the mother notices. The first movements happen between four and eight weeks after conception, although there is no way a mother will notice these, as the foetus is still the size of a lentil.

Even before the introduction of hormonal pregnancy tests in the 1970s, few women failed to notice the massive changes that sweep through the body after a fertilised egg implants in the

womb. The process is started by a flood of human chorionic gonadotropin (hCG to its friends) that gets released when the placenta first forms. This tells the ovaries a pregnancy is taking place and prompts them to keep producing progesterone while the placenta takes over producing oestrogen. The levels of both these two main female hormones will keep increasing throughout pregnancy. A third important hormone, oxytocin, makes its appearance later at the time of the birth.

Progesterone increases the mother's body temperature and metabolism, requiring extra energy, which is one reason she feels tired all the time. Progesterone also relaxes muscle tone, which is useful in later stages of pregnancy but early on affects the stomach and intestine, causing heartburn via acid reflux. Oestrogen changes her senses of smell and taste and is thought to cause the nausea, vomiting and stomach cramps of morning sickness. On top of all that, she has also just found out she is pregnant. It is not unreasonable for her to be feeling a bit fragile and largely in the dark, so that first touch of the baby is reassuring.

In the dark we can listen. Eavesdropping on life in the womb has been an important part of obstetrics for nearly 200 years. The humble stethoscope and its modern cousin ultrasound were both invented by maternity doctors. In 1816 René Laennec invented the stethoscope. He used to get embarrassed about having to put his ear to women's chests to listen to their hearts, so he made a listening tube. Laennec and his colleagues realised this new invention would let them listen to an unborn baby's heartbeat too. The first reports of foetal heart rates are from 1821, by Laennec's pupil Jean-Alexandre Le Jumeau de

THE LAUGHING BABY

Kergaradec (Wulf, 1985). The Y-shaped stethoscope appeared in 1851 and hasn't changed much since then. It is good enough to hear a baby's heart beating from the 22nd week of pregnancy, though this can depend on the orientation of the baby in the womb (and how much mummy's stomach is gurgling). It can even confirm if there are going to be twins.

Measuring foetal heart rate, and how much it varies, can tell doctors about the health of the foetus. The heart rate is controlled by two complementary systems, the sympathetic and parasympathetic nervous systems. The sympathetic nervous system causes increases in heart rate and the parasympathetic causes decreases. Normally they are in balance with each other and the heart rate gradually cycles up and down. A very fast or very slow heart rate, or even a lack of variability, can be a warning sign for doctors.

Medical ultrasound was invented by Ian Donald, an obstetrician working at the Glasgow Royal Maternity Hospital. He knew high-frequency soundwaves were being used in industry to detect flaws in welds and joints, and wondered if they would work on tissue. In 1955 he visited Glasgow engineering firm Babcock & Wilcox. Donald turned up with two carloads of medical specimens and found the industrial ultrasound device could detect the anomalous signals coming from tumours and cysts in the samples. Donald and colleagues built their own version and started using it in their diagnostic work. They wrote up their findings for the medical journal *The Lancet* in 1958 (Donald, Macvicar & Brown, 1958) kick-starting a revolution in medical diagnostics.

Ultrasound and heart-rate monitoring are the backbone of medical monitoring of foetal development. They have also been used by developmental scientists like myself to uncover what babies experience in the womb. Measuring changes in foetal heart rate allows us to determine when a foetus is surprised by something. Ultrasound lets us see how a foetus moves in response to sounds, movements and other stimuli. Coupled with what is known about the biology of the growing foetus, this lets us build a picture of what a foetus can learn in the womb.

Ultrasound shows that the clump of cells that becomes the heart is already beating by the sixth week after conception. At this point the embryo is the size of lentil, but already the ears, mouth and nose are visible. The eyes and nostrils are two little black dots, and arms and legs are still little stubs, the fingers and toes webbed. A six-week-old embryo will already move in response to touches around the mouth and nose area. These are simple reflexive actions but show that the nervous system is already beginning to arrange itself. This also gives a hint as to why mouthing is such an important exploratory skill for babies.

Fruit of the Womb

Over the next two weeks, the embryo doubles to blueberry-sized and then doubles again to the size of a raspberry (according to the fruit-and-veg-based measurement system that seems to be standard in all baby books ever written). At around 10 or 11 weeks the little strawberry has sleep and wake cycles. Mostly, the womb is a bedroom. Throughout the pregnancy

THE LAUGHING BABY

a foetus spends over 90% of its time asleep. Sleep cycles are about 40 minutes at a time, punctuated by a few minutes of activity, the amount of activity increasing as time goes by. When it's strawberry-sized, movements are minimal but clearly exhausting, as in-utero yawns have been seen as early as week 11 (Joseph, 2000).

Week 13 is peachy. This is the end of the first trimester, one third of the way through the pregnancy, and the embryo has developed sufficiently for us to start calling it a foetus. The first voluntary movements start to happen around 16 weeks, when the foetus is about 4.5 inches long (11.5 cm) and the size of an avocado. Periods of activity are accompanied by foetal callisthenics. The foetus is recognisably human by now, with a big round head and teeny-tiny fingers and toes.

Foetal development is not simply a process of growth from blueberry-sized blob to bouncing baby. Throughout this time the constant metamorphosis is no less dramatic than from caterpillar to butterfly. Cells are not only dividing and their numbers multiplying, but their functions change and they migrate within the body to different goals and different roles. That blueberry still has gill-like structures which become the jawbone and a tail which becomes the coccyx. Most internal organs are only fully formed by week 20, and neurons keep moving and connecting beyond birth.

As I've already mentioned, the expectant mother will feel the first tickles of movement somewhere between weeks 16 and 20 (avocado to small banana). This is typically when the midterm ultrasound takes place. The foetus is carefully

examined to check everything is developing as expected. On modern ultrasounds the sex of the baby can be seen if you know what you are looking for. Chances are the foetus will be asleep during this exam, but if it is moving, you might be in for a nice surprise. In March 2015, Jen Hazel and her husband went for their 14-week ultrasound scan with their doctor in Olympia, Washington. During the scan the foetus clapped her hands together. As Jen describes it:

We went in for an ultrasound and the baby clapped three times on screen. Not to the music, just clapped three times. So my doctor, he said, 'Well, let's sing a song.' My husband grabbed his video and the doctor reran the ultrasound and played the claps and I sang and he sang with me 'If you're happy and you know it [clap your hands]'.

Their singing isn't great – Jen is laughing too much and her husband doesn't seem to know all the words – but it's a delightful video. And when it was uploaded to YouTube it understandably went viral. At the time of writing it has nearly 12 million views.

So could a 14-week-old foetus be happy? Here we get to the heart of this chapter. Is there a time before smiles? When does happiness and contentment begin? Are they present from the very start or do emotions only turn on sometime after birth? Jen's daughter, Pip, was born safe and healthy. She is a happy, playful baby and she still likes music. But what about when Pip was still a lemon-sized foetus of 14 weeks? Was she happy and

THE LAUGHING BABY

did she know it? Could she know it? A single fertilised egg, a zygote, cannot know or show happiness. Nor can the little ball of cells in the blastocyst or even the yawning strawberry-sized embryo. From the many parental reports in my baby laughter survey, I am confident a baby of just a few weeks old can show genuine contentment. So when do the lights come on? When can a smile really be a smile?

No research exists on foetal pleasure. Indeed, it would be hard to know where to start. But foetal pain is a good guide to pleasure. Pleasure and pain are supported by similar circuits and evidence is accumulating that by end of the second trimester, at around 24 to 25 weeks post-conception, a foetus can feel rudimentary pain. The Royal College of Obstetricians and Gynaecologists (RCOG) published a detailed report in 2010 that reviewed the available evidence. They concluded that foetal awareness of pain is not possible before 24 weeks (RCOG, 2010).

For anyone to experience pain, nerve signals from the unpleasant stimulus must reach a cortex capable of processing them. If the signal from some part of the body doesn't reach the brain, we will only experience numbness. This is how a local anaesthetic works: by blocking the nerve signals at source. If the signals reach the brainstem and thalamus but aren't passed upwards to the cortex, we won't feel anything. This is how general anaesthetic works: by blocking all signals from the brainstem to the cortex.

Before 24 weeks a foetus cannot experience pain because the brain is not fully connected. In particular, the thalamus,

which is a kind of junction box between brain and body, is not properly wired to the cortex (the wrinkly thinking bit). This is not too surprising when you appreciate how complicated the brain is, and how tangled the wiring. Every part needs to talk to every other part and those wires are long trailing tails of brain cells called axons. To connect one place to another, the cells must be born in one area and migrate to the other, trailing the tail behind them.

As you can imagine, this is complicated and the wiring cannot happen until there is somewhere to connect to. The thalamus and the cortex, initially known as the cortical plate, grow separately. A further group of cells develops in a 'subplate zone' beneath the cortex. From 12 to 18 weeks connections from the thalamus arrive in the subplate zone and then wait as the cortical plate matures. At around 24 weeks they recommence their journey to connect to all areas of the cortex, a process that continues to week 32. Also at 24 weeks, the neurons of the subplate themselves migrate into different areas of the cortex, effectively wiring these areas together. Both these processes are important to an awareness of pain. An 18-week-old foetus moves away from a needle prick and even releases stress hormones, but it doesn't feel the pain. The signals can reach the thalamus and potentially the subplate zone, but they can't ascend any higher. The withdrawal of the limb and the hormone release are reflexes that come from the brainstem.

By 24 weeks nerve signals start to get through the cortex. Brainwave recordings performed with very premature infants show coordinated neural activity in response to a heel

THE LAUGHING BABY

prick from 24 weeks of pregnancy. This sets the lower limit recommended by the RCOG. But, as they observe in their report, although this is the theoretical minimum age that pain can be felt, awareness might come later. Electroencephalogram (EEG) activity is not continuous at this point, as it would be in an adult or a newborn. It is not clear whether the pain is being perceived or if the experience requires an experiencer who has yet to arrive.

From the 24th week the brain begins connecting itself up in earnest. The sensory inputs from hearing, vision and touch pass through to the relevant areas of the cortex. Reciprocal connections downward from cortex to brainstem begin by week 26. Feedback loops start to form and the foetus can begin to exert voluntary control over their tiny womb-world. They are starting to hear, feel and even see things, and starting to learn.

It is unlikely the foetus has any kind of experience before this. But in the third trimester they can absorb a surprising amount. Studies looking for changes in foetal heart rate have found that from 26 weeks onwards the foetus can respond to and learn to ignore repetitive vibrations. They can respond to changes in levels of external illumination, to hearing their mother's voice and to feeling her touch through the walls of the womb (Marx & Nagy, 2015).

My favourite study of this kind was done by Peter Hepper of Queen's University Belfast (Hepper, 1991). He tested newborn infants of just two to four days old to see how they responded to music they had heard in the womb. To do this he took advantage of the fact that many mothers watched soap operas.

Half of his sample were fans of the show *Neighbours* and half were not. This meant that half the babies had heard its catchy theme tune many times while in the womb. When he played it to the two groups in the maternity ward, the movements and heart rates of the *Neighbours* babies dropped relative to the control group, as they seemed to enter an alert listening state. To double-check they were not just more likely to respond to music, he tried the *Coronation Street* theme and got no response. A second experiment got similar results, but this time playing the theme tunes to babies still in the womb through headphones on the mummies' tummies. Hepper argues that the babies were learning not just the music, but were associating it with the calm and relaxed state the mother went into as she sat down to enjoy the soap.

One curious feature of most of these studies is that it doesn't seem to matter if the foetus is active or 'asleep'. Recall that foetuses are only active about 10% of the time and the periods of activity in the womb are a dreamlike state not easily comparable to the wakeful attention of a newborn baby. In fact, some researchers go further and say the whole pregnancy is spent with the foetus in a deep sleep. Consciousness expert Christof Koch wrote for *Scientific American Mind*:

I wager that the foetus experiences nothing in utero; that it feels the way we do when we are in a deep, dreamless sleep. The dramatic events attending delivery by natural (vaginal) means cause the brain to abruptly wake up, however. The foetus is forced from its paradisiac existence in the protected, aqueous and

THE LAUGHING BABY

warm womb into a hostile, aerial and cold world that assaults its senses with utterly foreign sounds, smells and sights, a highly stressful event. (Koch, 2009)

It is a vivid image, but I disagree that life in the womb is spent in such a sedated state. The changes in infant heart rate in various studies suggest they are responsive to events around them and I think some experiences can even be pleasant for the foetus. Anecdotal reports of babies pictured smiling in ultrasounds have been around since 2000, when the resolution of scans became good enough to show facial expressions. Looking at this evidence systematically, the psychologist Nadja Reissland at the University of Durham and colleagues have identified seven foetal facial expressions and confirmed that both crying and laughing are ‘practised’ in the womb (Reissland, Francis, Mason & Lincoln, 2011).

Using modern ‘4D’ ultrasound, which has good spatial and depth resolution in real time, Reissland’s team scanned two foetuses on multiple occasions between 24 and 35 weeks. They recorded 10 minutes of facial expressions on each occasion and used a standard coding scheme to objectively classify what they saw. Facial expressions can be broken down into their component micro-expressions (pursed lips or raised cheeks). The coding scheme designed for very young babies was adapted to define sets of expressions that went together to form a ‘cry face’ and a ‘laughter face’. Some, like a wrinkling of the nose, were common to both. Others defined just laughter (tongue sticking out and lips pulling back) or crying (pulled down lower

lip and furrowed brow). Combining data on both fetuses (both girls), they found that the crying expression increased from 0% to 42% occurrence while laughing faces increased from 0% to 35% between the 24th and 35th week respectively. Pleasant expressions were as common as expressions of distress, and both gradually appear as the foetus itself gradually gains awareness. From the baby's personal point of view, there is no time before smiles.

Therefore, when asked, I say the grimaces and smiles of infants in utero reflect something genuine from around week 25. I believe this is the start of foetal awareness of pleasure and pain. This is not too different from the 24-week mark suggested in the RCOG report. But, for idiosyncratic reasons, I prefer week 25, when the universal fruit-and-veg scale says the foetus has reached the size of an aubergine.

A former girlfriend of mine, Belinda, always used to say that the springy tactile pleasures of aubergines reminded her of the chubby arms, legs and tummies of young babies. In the supermarket she couldn't resist giving the aubergines a playful squeeze. When I started to work with babies, she would often ask me, 'How are the aubergines?' It became our secret synonym. And then, a few years ago, while Belinda was pregnant with her daughter Rose, I got a delighted text message letting me know the pregnancy app on her phone had informed her that, after 25 weeks, her blueberry had graduated, and she was now the proud possessor of a little aubergine of her own.

Chapter Two: Happy Birthday

The first thing newborn babies do is cry because their parents haven't bothered to sing 'Happy Birthday' to them.

— Someone on the internet

You don't remember your zeroth birthday, but your mother certainly does. For the last few months of pregnancy she didn't require a smartphone app to tell her that you were swelling up from cute little aubergine through honeydew and cantaloupe to goddamn watermelon. For nine months she had been imagining this moment. The party bag had been packed for weeks waiting for the day. There may have even been a few false alarms. But then the time finally arrived.

Well, almost: babies don't like to rush their grand entrance; nor does the mother's body. The average length of normal labour for a first-time mother is about eight hours and it is largely controlled by automatic processes. The main feature of labour is the regular coordinated contractions of the muscles of the uterus, which are controlled by pacemaker cells, like in the heart. The contractions grow in frequency and intensity, starting 10 minutes apart and increasing to two minutes apart near the end.

Happy Birthday

Assuming no medical complications, nature then takes its course. But nature can be terrifying and deadly. Historical novelist Philippa Gregory memorably observed that it used to be that ‘men die in battle; women die in childbirth’. Historically, mothers had a one in 100 chance of dying as a result of giving birth. It is still that bad, or worse, in some parts of the world. A World Health Organisation (WHO) report from 2015 says the lifetime chance for 15-year-old girl in Africa dying from a cause related to maternity was one in 37. In Europe that number is one in 3,400.

Babies fare even worse. Across the world one in every 45 births is a stillbirth. And of the babies that do survive, 49 out of every 1,000 don’t make it to their first birthday. As health statistician Hans Rosling pointed out, mothers and young infants are the most vulnerable and invisible victims of wars, famines and other humanitarian crises. The biggest win one can make for human health is to improve the care of new mothers and their babies.

In Vienna General Hospital in the 1840s there were two maternity wards, Clinic 1 and Clinic 2, which admitted women on alternating days. The first clinic was attended by medical students, the second clinic by midwives. Pregnant women admitted on Clinic 1 days begged to be admitted to Clinic 2, as it seemed to be common knowledge that Clinic 1 was cursed. Data collected from 1842 to 1846 were incontrovertible: maternal death rates were 60% lower in Clinic 2, the midwives’ clinic. A junior doctor, Ignaz Semmelweis, was tasked with investigating this. He found no differences in the clinics themselves, nor the

THE LAUGHING BABY

delivery procedures. He made the suggestion, unusual for the time, that the medical students wash their hands with strongly chlorinated water. When they did, death rates dropped to levels found in Clinic 2. The medical students had come often from dissecting cadavers in anatomy classes. They didn't wash their hands because, well, why would they? There was no reason. This was decades before the germ theory of disease was proved by Louis Pasteur and Joseph Lister.

Semmelweis presented his findings to his superiors. He could not explain why the washing of hands helped, so they did not adopt his suggestions. Shortly afterwards he was fired and he returned to his native Hungary. Hospitals where he worked showed similar improvements, but his new colleagues would not permanently adopt handwashing either. He spent 20 years in increasingly angry correspondence with the European medical establishment. He was largely ignored. He died in an asylum in 1865, a broken and defeated man. In psychology, the Semmelweis Reflex is a cognitive bias where we reject new evidence when it contradicts existing beliefs or established paradigms.

Curiously, right now in the Western world, with universal access to advanced medical services, the answer to healthier births might also be more midwives and fewer doctors. This was the recommendation of an influential report in the *British Medical Journal* by Mary Newburn, Director of Policy for the National Childbirth Trust, and colleagues (Johanson, Newburn & Macfarlane, 2002). They recommended that the whole culture around birth needed to change to one 'of birth as a normal physiological process, and having a commitment

Happy Birthday

to one-to-one supportive care during active labour'. Having medical staff on standby during birth is important, but medical staff tend to medicalise everything. In Finland, where birth is treated as a physiological process, 11% of births are by caesarean section. In the United Kingdom it is 25% and in the United States it is 35%. The estimated medically necessary level is thought to be 5% to 10%. At risk of lawsuits, and operating on a precautionary principle, doctors will run tests and even perform operations that are not needed. But there is more to it than that.

When birth is presented to mothers as a medical condition to be treated, then, not unreasonably, they seek more treatment. They have more fear of the act of giving birth itself. They seek more epidurals and pain management. In a medical setting, midwives defer to clinicians. Even maternity doctors themselves feel that they rely too much on medical procedures. When birth is viewed as a natural, physiological process, outcomes are better for mother and baby, and mothers have a better birth experience. The report recommended that, as far as possible, midwives not doctors should direct the childbirth process. It should take place in a non-medical setting and mothers should get to know and trust their midwives.

I spoke to two midwife friends of mine to understand what their role is and to get a better perspective on childbirth. Corinne is energetic and irreverent rather than medical and matronly. She seems more likely to be found marching against injustice than patrolling the wards of a hospital. In fact, that might be where we first met. Corinne has 10 years' experience

THE LAUGHING BABY

as a 'baby catcher'. Natalie is small, sparkly and still slightly Dutch despite nearly two decades in London. We met 19 years ago on the very first day of our psychology degree. I remember she was always the first to finish any piece of coursework and she did all the practice essays that I never quite found time for. Natalie used to run marathons for fun, a hobby I didn't understand at the time, but one that probably prepares you quite well for being a midwife.

The word midwife is from the old German '*mit* (with) *weib* (woman)', meaning someone who is with the mother. As Corinne points out, it is a role as old as humanity. For at least as long as we have been walking upright we've needed midwives. The transition to walking changed the shape of our pelvises, narrowing the passage. Combine that with our ballooning brains, and our big-headed babies need help into the world. Fortunately, the reason we grew so brainy was because we are a sociable species. So social support was there for labouring mothers.

When I ask Corinne and Natalie what the main role of a midwife is, their answers are very similar: midwives support mothers to have the birth they want. Modern midwifery is built on three key principles: informed choice, choice of birthplace and continuity of care. The most important of these is informed choice, which is something more than informed consent; it is empowerment as opposed to acquiescence. Midwives want the mother to feel in control. Natalie explains that having a birth plan is very helpful here; the important decisions have been made in advance. The last thing a woman in labour needs is to be asked a lot of questions. She can

Happy Birthday

be directed along the path she has already chosen and the midwife will help smooth the way. If her own midwife is not available at the crucial moment, another midwife can consult the plan.

Corinne explains that for most of labour, ‘Our job is to watch and wait. To observe. Sit on your hands. Be responsive to the woman’s needs.’ Some need a reassuring hand, some need to be left alone. Some need ice cubes to crunch or something sugary to keep them going. As labour progresses, midwives give the mother options to choose, not decisions to make. When there are complications the midwife is the calming voice who makes sure the mother knows what is happening and why.

If anything disrupts the calmness, it can delay labour. Ina May Gaskin, the pioneering American midwife who is credited with reintroducing natural childbirth to the United States, observed:

The presence of even one person who is not exquisitely attuned to the mother’s feelings can stop some women’s labors. All women are sensitive. Some women are extraordinarily so. We learned this truth by observing many labors stop or slow down when someone entered the birth room who was not intimate with the laboring mother’s feelings. If that person then left the room, labor usually returned to its former pace or intensity. (p.138, Gaskin 2010)

This is also the principle behind hypnobirthing. In the last months of pregnancy some mothers learn relaxation and breathing techniques that they can apply when in labour. They

THE LAUGHING BABY

are learning to hypnotise themselves, but this is not to achieve some numbing trance. It worked for my sister Ishbel, who was so calm for her first birth that she had trouble getting admitted to the hospital. They didn't believe she was so advanced with labour and wanted to turn her away. On her recommendation, my aubergine friend Belinda tried it too, with similar success. The idea is not block out the anxieties or the pain, but to make you more aware of the present so you can relax into the actual experience rather than worrying about what it might turn out to be. Starting labour calm and confident helps the natural physiological processes carry you as far as they can. Drugs can always come later. The most important drug is one your body makes itself – oxytocin.

Oxytocin

Oxytocin is the unquestioned chemical queen of childbirth. 'Good old oxytocin', as Natalie calls it. In the last decade oxytocin has also developed an overhyped reputation as the 'love drug', 'hug hormone' and 'cuddle chemical'. It is supposedly present in large quantities when people fall in love and in smaller amounts when they have sex or even hug. Participants in psychology studies have had oxytocin squirted up their noses before having their brains scanned. These studies have claimed it increases empathy, reduces introversion and could even treat autism. The science behind most of these claims is at best 'unproven'. Early studies didn't have enough participants to be sure, or haven't been replicated. It is not even clear whether nasal oxytocin can make it into the brain.

Happy Birthday

Levels of maternal oxytocin gradually rise in the late stages of pregnancy, when it increases feelings of contentment, calmness and security around a partner. Labour releases it in even greater quantities, increasing contractions. More is produced when the descending baby stimulates the cervix and vagina, creating a positive feedback loop. If labour is not progressing quickly, mothers may be put on an oxytocin drip.

Oxytocin is not the only chemical involved in natural childbirth. As labour reaches its crescendo, a complex network of hormones and chemicals work in concert in mother and baby. Relaxin relaxes the mother's ligaments, and in the baby a protein called noggin makes the head squidgy and deformable to help it squeeze out. Early on, fast-acting stress hormones epinephrine and norepinephrine can slow down or suspend labour if danger is perceived. At the very end of labour a surge of these same chemicals makes sure both mother and baby are alert after the birth.

The slower-responding stress hormone cortisol also builds to 10 times its normal level during birth. This seems to promote the formation of receptors for prolactin, the breastfeeding hormone. Endorphins are released, which aid a mother's ability to cope with stress and pain, and induce a slightly altered state of consciousness. This rises to a kind of euphoria at birth. Endorphins also seem to serve a second role in priming the reward centres in the mother's and baby's brains, preparing them both to imprint, bond and learn how to breastfeed. Maternal endorphins also directly stimulate the release of prolactin. Prolactin is the hormone of breast-milk synthesis but

THE LAUGHING BABY

has around 300 other effects on the body, one of which is to stimulate oxytocin synthesis.

This complex web of individual effects and self-regulating cycles is often disrupted in delivery interventions. For example, one issue with epidural pain relief is that the lack of pain prevents the epinephrine-norepinephrine surge. There is less of these hormones in the mother's blood and less is passed to the baby, leaving him or her underprepared for delivery. Similar effects are found with caesarean sections, where caesarean-born babies have much lower stress at the time of birth but much higher one hour later. Caesareans seem to slow the bonding process, but this is partly because the mother is in recovery. Childbirth is a very complicated system and most of the mechanisms still aren't fully understood. These last few paragraphs have attempted to summarise Sarah Buckley's monumental 248-page report on the topic, which itself summarises research from 1,141 other papers (Buckley, 2015).

Corinne tells me that babies are born in a kind of stasis. They do not begin to wake up until after the umbilical cord is cut and they have filled their lungs with oxygen. 'Before that happens they are different. Their colour is different. They are not looking outwards.' Where possible, midwives leave the umbilical cord to pulsate for three minutes to push all the blood stored in the placenta into the baby. The first breath closes holes in the heart, changing the baby's circulation so that blood starts to go through the lungs, not the placenta.

Corinne busts a myth I was not sure about. Doctors don't dangle newborn babies upside down to drain their lungs.

Nor do they spank them to make them cry and start their breathing.

No! That would be cruel. The action of being squeezed out of a woman is usually enough. If not, rubbing the baby with a rough NHS towel or tickling their feet will stimulate breathing. Just as how, in other mammals, a mother licks her newborn pups to stimulate them to take their first breaths.

Human mothers aren't expected to lick their babies, but since 2014 most childbirth organisations, including the American Academy of Pediatrics (AAP) and the WHO, have encouraged early skin-to-skin contact. Babies used to get whisked away straight after birth to be weighed and measured. Newborns were kept in nurseries and only brought to mothers for feeding. This was supposed to aid mothers' recovery. But the importance of the transition time has been rediscovered. The WHO says that 'the process of childbirth is not finished until the baby has safely transferred from placental to mammary nutrition'.

As Corinne vividly explains, 'Now, where possible, babies are born out of the mother, onto the mother.' A mother's body temperature will increase by a degree or two to keep the baby warm enough and babies have an instinct to crawl towards the breast and seek out the nipple. They work by touch and smell, and they may need a bit of time to get started – they need to wake up enough first. This is also an opportunity for baby to be colonised by the mother's bacteria and it helps the mother start

THE LAUGHING BABY

to acclimatise. In Natalie's experience, no one is ever prepared to see their baby for the first time. It takes time to sink in and that is just the beginning of the bonding process.

When it comes to childbirth, experiences can be very varied. Some women do have a wonderful experience, but others experience a nightmare. I haven't yet encountered anyone who would call it 'fun'. 'The joy comes when you have the baby in your arms, which colours everything with joy. But I have never seen anyone enjoying it as it happens,' Corinne reports. Like running a marathon, the joy of childbirth happens after it is complete

For fathers or partners, that time immediately after the baby is born is where the greatest changes take place. During pregnancy, the baby has been somewhat abstract, but now they can hold the baby and interact with it. A partner's oxytocin and prolactin levels rise dramatically at this point. Remarkably, by the end of the first week a father's oxytocin levels can be as high as the mother's.

The emotional and hormonal high the partner feels can often contrast with an equivalent slump for the mother. The first week can be a very difficult time. There is a huge hormonal crash after birth. The placenta is no longer signalling production of pregnancy hormones and the body starts trying to undo nine months of being pregnant. During the first week at home the mother's body is trying to recover, but she's not getting much rest or relaxation with a new baby to care for and worry about.

Utterly exhausted and at the end of a nine-month odyssey, the return home can also feel anticlimactic for the mother. Mothers

Happy Birthday

who had a difficult delivery often feel particularly isolated. The focus is on the baby and she is expected to be grateful for everything, while her own identity fades and there isn't much opportunity to deal with her own needs. It is totally normal to feel overwhelmed or even depressed straight after birth. A recent study found that 81% of women experience a mental health issue during or after their pregnancy (Royal College of Obstetricians and Gynaecologists, 2017). The deep love for the baby doesn't always come straight away, but mothers cannot easily talk about this.

On top of this, a new mother is usually the only one responsible for that baby 24/7. If anything happens she will never not blame herself. Asked about this time, Corinne tells me, 'In my ten years as a midwife, visiting them at home in the first week, I've never seen new parents who didn't look shell-shocked.' Everyone will be overwhelmed by some aspect of first-time parenting, but it gets easier and it is OK to ask for help.

One of the weirdest things about newborn babies is the raw fact of their existence. Here is a whole new person suddenly central to their parents' lives. When my nephew Tycho was born, my sister had some trouble leaving the room he was in. It was hard to process that he had an independent existence, and she had to keep checking. Birth is the opposite of death, but some of the feelings it creates are not so dissimilar to grief. Adjusting to the presence or absence of a significant other is a process. For mothers, a second child can bring even more ambiguous feelings. It changes the relationship with the first child; mother and baby

THE LAUGHING BABY

number one are no longer that indivisible pair. Mothers can feel resentment for what has been lost. Again, this is a completely normal, but can be hard to talk about.

Babies recover fast from birth. ‘Babies are resilient,’ Corinne says. ‘I have seen babies go through really traumatic births and they heal up pretty quickly. Heads getting squished looks very traumatic. The first time I saw that as a student midwife I ran off and cried in the toilets for twenty minutes.’

The idea that the trauma of birth can follow you through life has no scientific support. Except for the rare cases with clear medical complications, a traumatic birth is only a small setback. Labour and birth are just one event in the development of a baby. No single moment defines this time; all are important. And although it feels like a rollercoaster, the overall direction of travel is upwards.

Hello, Little Monkey

Some babies are born with a fine black hair on their body. This disappears quite quickly. When I was born, I was my mother’s first child of three and she was well pleased with her achievement (as indeed am I). But I was a little furry. Sitting up in her hospital bed, she delighted in scandalising the nurses by asking them to bring her ‘her monkey’.

‘Mrs Addyman, you can’t say that! He’s your little baby!’

‘Yes, but he looks like a monkey!’

‘He’s a beautiful baby.’

‘A beautiful monkey! Give me my monkey!’

Index

- abortion, 11–12
accommodation, 192
actigraphy, 77
Adam, Kristine, 79, 83
Adams, Douglas, 209, 373
Adolph, Karen, 156, 199
Adrian, Edgar, 127
Aerosmith, 267
Ainsworth, Mary, 57, 100–3
Alexander, Richard, 126
Allin, Arthur, 117
altruism, 364
American Academy of Pediatrics
(AAP), 33, 180
American Sign Language, 310, 312
amniotic sack, 108
amygdala, 52, 90
anabolism, 82
Anderson, Laurie, 266
anterior cingulate cortex (ACC),
127–8, 133
Argent, Sarah, 150
Aristotle, 7, 60, 62, 128–9, 195, 233,
374, 376
arousal, 346
Asada, Minoru, 132–3
Asendorpf and colleagues, 349
Ashworth, Anna, 249
Asimov, Isaac, 160
Aslin, Dick, 191
assimilation, 192
attachment, 57–8, 101–2
attachment objects, 209–10
attention span, short, 199, 215
Auden, W. H., 66–7
autism, 354–5
autonomous nervous system, 127
babbling, 294–6
‘baby brain’, 52
Bach, Johann Sebastian, 267
bacteria, maternal, 33
Baillargeon, Renée, 163–4, 215
Ball, William A., 162–3
Ballew, Chris, 268
Bancel, Pierre, 295
Barnes, Jacqueline, 370
Baron-Cohen, Simon, 354–5
Barr, Rachel, 299
Barrett Feldman, Lisa, 232–5
Barrie, J. M., 7
Barros, Fernando, 49
Bayesian probability, 201–5, 207–8,
210, 212, 328, 335–6, 376
Beck, Jeff, 275
Bedford, Rachel, 180
Begum Ali, J. J., 137–8
behaviourism, 101–2, 123, 308–9
Belsky, Jay, 370
Bergmann, Bernard, 80
Bergonzi, Rosie, 271
Bergson, Henri, 246
Berne, Eric, 215
Berridge, Kent, 62–3
Bick, Esther, 236, 367
Bieber, Justin, 241
Bilko, Agnes, 65
Blakemore, Sarah-Jayne, 133–4
Bloom, Paul, 64–5, 148, 363, 365
Blur, 260, 267
Bocelli, Andrea, 269, 272
body language, 115
Bonatti, Luca, 335–6
bonobos, 119, 312–13, 315
Book of Genesis, 300, 321

THE LAUGHING BABY

- boredom, *see* habituation
 Borge, Victor, 218, 375
 Bowlby, John, 55, 57–8, 101–2, 236, 367
 Brahms, Johannes, 267
 brain size, 224–5
 Braithwaite, Peter, 271–2
 breastfeeding, 49–52, 104
 Bremner, Andy, 136–8
 brephophobia (fear of babies), 245
 Brito, Natalie, 299
 Brown, Pam, 249
 Brownian motion, 173
 Bruner, Jerome, 216, 307
 Buckley, Sarah, 32
 Buddha, 233, 359, 365
 Bühler, Charlotte, 366
 Burgdorf, Jeff, 120, 123–4
 Burke, Leo J., 96
- C&G Baby Club, 265–6, 275, 278–80
 caesarean sections, 27, 32
 Californian sea hare (*Aplysia californica*),
 185–6, 189
 Campos, Joseph, 156
 Cantor, Robert, 83
 Carey, Susan, 327–9
 Carnot, Nicolas Léonard Sadi, 169
 Carpendale, Jeremy, 332–3
 Carr, Jimmy, 240, 247–8
 Cartesian dualism, 117, 143–8
 Cartesian materialism, 145
 Cartesian theatre, 145–6
 Cartwright, Rosalind, 90
 Cassels, Tracy, 78
 categories, 174–8
see also concepts
 Catholic Church, 12
 cats, 119, 121, 174, 176, 185, 187, 205,
 257, 322, 325–6, 328
 kittens, 154–5
 causality, 200–5
 Chaplin, Charlie, 245
 Charles, Pastor Mark, 222
 Chater, Nick, 314, 335–6
 childbirth, 24–36
 chimpanzees, 37–8, 42, 63, 86, 146,
 255, 286, 313, 324, 361
 and cooperation, 364–5
 Nim Chimpsky, 308, 310–12, 315–16
 social group size, 224–5
 and theory of mind, 351–3, 357
 and tickling, 119–20, 130
 Washoe, 310, 312, 314–15
 Choi, Soonja, 333
 Choi, You-Jung, 350, 362
 Chomsky, Noam, 5, 308–11, 313–16, 325
 Christiansen, Morten, 314
 circadian rhythms, 82–3
 Cirelli, Chiara, 84
 clowns, 245–6
 Cohen, Les, 186, 191
 Collins, Gina, 150
 common sense, 160
 concepts, 321–9, 356
 consciousness, 7, 127, 144–7, 231, 238
 neural correlates of, 147
 core knowledge, 164–6
 Cornwall, Francesca, 45
 Corsaro, William, 367–8
 Cortés, Ricardo, 99
 cortex, 18–20, 41, 156, 189
 cortisol, 31, 78, 109
 coulrophobia (fear of clowns), 245
 counterfactual thinking, 338
 Cowell, Jason, 360
 Cowles, Henry, 198
 Coyne, Matt, 151
 coyness, 256, 346
 cross-hands deficit, 136–8
 Csibra, Gergely, 257, 337
 Csikszentmihalyi, Mihaly, 194–5, 376
 culture, 249–58
 curiosity, 196–205
 cuteness, 241–2
- Dalai Lama, 89
 dance, 262–4
 Darwin, Charles, 1, 5, 121, 124–7, 129,
 229, 232, 234, 256, 264, 332
 Decety, Jean, 360
 Dekker, Tessa, 157
 Denil, Misha, 166
 Dennett, Daniel, 144–5
 Descartes, René, 5, 129, 142–4, 146,
 148, 336
see also Cartesian dualism;

Index

- Cartesian materialism; Cartesian theatre
- Dewey, John, 197–200, 203, 230, 320
- Dezecache, Guillaume, 226
- diabetes, 49
- Dickens, Charles, 108, 184
- Disney, Walt, 241
- Dissanayake, Ellen, 272–4
- dogs, 40, 119, 123, 146, 176, 185, 187, 235, 301, 322, 325–6, 328, 353
and music, 265–6
- dominatrix, 126
- Donald, Ian, 14
- Donaldson, O. Fred, 149
- dopamine, 52, 59
- drawbridge task, 163–4
- dreams and dreaming, 80, 83–9
- Drozd, Kenneth, 334
- dummies, 152
- Dunbar, Robin, 224–7, 264, 286, 375
- dynamic causal modelling, 206
- ‘eating the baby’, 138–9
- ecological self, 145
- Einstein, Albert, 168, 171, 173, 196
- Ekman, Paul, 233–4
- elephants, 251–2
- Elizabeth II, Queen, 240
- embodiment, 117, 145
- Emerson, Ralph Waldo, 344
- emotions, 228–40, 254–5
- empathy, 359–65, 369
- end-bulbs of Krause, 107
- endorphins, 31, 225, 264
- Enright, Anne, 47, 58–9, 68
- entropy, 170, 173, 207
- Epicurus, 61
- epidural pain relief, 27, 32
- epigenetics, *see* gene expression
- epinephrine, 31–2
- epiphenomena, 230
- Esseily, Rana, 339
- ethology, 40, 57
- Everett, Daniel, 314
- evolution, 1, 38, 40, 57, 112, 166
and art and culture, 272–4
and attachment, 101
and blurry vision, 154
and concepts, 328
and cooperation, 263–4, 365
and core knowledge, 203–4
and cuteness, 241–2
and emotions, 233–4
and language learning, 314–16
and laughter, 4, 223–8, 376
and learning, 257–8
and longevity, 250–2
and music and dance, 264–5
and music and language, 285–9
and sleep, 80, 82
and theory of mind, 354, 357
and tickling, 124, 126–7
and white sclera, 219
- experience sampling, 195
- extraversion–introversion dichotomy, 346–7
- eye contact, 52, 130, 219–20
- Eysenck, Hans, 346–6
- facial recognition, 40–1, 165, 219
- Falk, Dean, 286–7
- Farroni, Teresa, 219
- fathers, 34, 52, 114, 118, 258
- Feigenson, Lisa, 166
- Feldman, Ruth, 51–4, 58
- Ferber, Richard, 75–7, 96, 239
- Fernald, Anne, 213
- Ferns, Michael J., 280–1
- ferrets, 208–10, 212
- Field, Tiffany, 113
- Fiser, József, 208
- flavour preferences, 65–6
- flow states, 195
- foetal development, 15–23
awareness of movement, 141
experience of pain, 18–9
facial expressions, 22–3
knowledge of up and down, 141
response to music, 20–1
and sense of touch, 103
sleep cycles, 16
- foetal heart rate monitoring, 14–15, 20
- Fogelquist, Lotta, 369
- Ford, Gina, 74–6

THE LAUGHING BABY

- Fosse, Magdalena, 87
 Fotopoulou, Katerina, 357
 Fouts, Roger, 312, 314–15
 free-energy principle (FEP), 206–8,
 357
 Freeman, Morgan, 99
 French, Bob, 170, 176, 185, 298, 324
 Freud, Anna, 55
 Freud, Sigmund, 5, 54–5, 66, 68–9, 91,
 207, 244–5
 Friedman, Neil, 131
 Friedman, William, 170
 friendships, 344, 349, 366–71
 Frisch, Karl von, 40
 Friston, Karl, 205–12, 216, 328–9, 331,
 358, 376
 Frith, Chris, 134, 206
 Frith, Uta, 355
- game theory, 365
 Gardner, Allen and Beatrix, 310
 Gardner, Randy, 80
 Gaskin, Ina May, 29
 Gell-Mann, Murray, 196
 gene expression, 109–12
 Gergely, György, 257, 337
 Gerhardt, Sue, 237
 gestation periods, 37
 ‘ghost in the machine’, 145
 ghrelin, 59
 Gibson, Eleanor, 152, 155, 158
 Gilbert and Sullivan, 270
 Gjersoe, Nathalia, 149–51, 359
 Glazer, Sam, 270–2
 glymphatic system, 84
 Goethe, Johann Wolfgang von,
 183–4
 golden-haired tamarind, 64
 Goldilocks Effect, 191–2, 194, 215
 Google DeepMind, 166
 Gopnik, Alison, 196–7, 200, 203–5,
 338, 353, 376
 Gordon, Mary, 362
 gorillas, 37, 63–4, 119, 242, 313,
 315
 Gospel of John, 300, 321
 Grande, Ariana, 275
 grandmothers, 250–2, 258
 gravity, 161–2, 166, 169
 great apes, 37, 63–4, 128, 130, 225
 ape language, 308–16
 see also bonobos; chimpanzees;
 gorillas; orangutans
 Greek alphabet, 167
 Greeves, Lucy, 247–8
 Gregory, Alice, 78–9, 85, 89, 91, 94, 98
 Gregory, Philippa, 25
 Grock the Clown (Charles Adrien
 Wettach), 245
 grooming, 225, 227–8
 Group C nerve fibres, 127
- habituation, 184–9, 191
 Hall, G. Stanley, 117, 136
 Hamlin, Kiley, 362
 Hardy, Oliver, 244–5
 Hart, Betty, 307
 Hawkes, Kristen, 250–2
 Hawking, Stephen, 167
 Hazel, Jen, 17
 Heap, Imogen, 275–81
 heel-prick tests, 19–20
 Hein, Alan, 154–5
 Held, Richard, 154–5, 158
 Hendrix, Jimi, 347
 Hepper, Peter, 20–1
 Herold, Don, 1
 Herzog, Werner, 99
 hierarchy of needs, 194
 hippocampus, 87, 90, 109–10, 189
 Hirst, Damien, 260
 Hochmann, Jean-Rémy, 328–9
 Hoicka, Elena, 339–40
 hominins, 225, 227, 251, 253, 286
 honest signals, 226
 Horn, Gabriel, 39
 Hrdy, Sarah, 258
 human chorionic gonadotrophin
 (hCG), 13
 Humboldt’s night monkey, 63, 86
 humour, theories of, 243–8
 hunter-gatherer societies, 86, 250–1
 hyoid bone, 285
 hypnobirthing, 29–30
 hypothalamus, 127

Index

- imitation, 41–4
imprinting, 39–40, 165, 231, 327
infant-directed speech (IDS), 282–4,
286
infant massage, 112–15
infanticide, 242
Inside Out, 229, 232–4
insulin, 59
interactive specialisation, 41
intersubjectivity, 238, 273
- Jackson, Samuel L., 99
James, William, 60, 192, 230
Janáček, Leos, 268
Janisch, Michael, 268
Jesus Christ, 359–60
Jiang Xiaoshan, 81
Jillette, Penn, 38
Johnson, Mark, 39–42, 153, 165, 219
joke, first, 128–30
Joys of Toys, The, 149–51, 159–60, 168,
359
Jung, Carl, 346
- Kandel, Eric, 185–6, 189
kangaroo care, 104–5, 113
Kant, Immanuel, 243
Karmiloff-Smith, Annette, 73–4, 181
Karp, Harvey, 76
Kay, Peter, 248
Keaton, Buster, 245
Kennel, Keith, 351
Kettner, Viktoria, 332–3
Kidd, Celeste, 191–2, 252
Kindenschema, 241–2
Kintz, Jarod, 350
KISS, 122
Klein, Melanie, 53–6, 58, 138
Knight, Lucy, 271–2
Knutson, Brian, 120–2
Koch, Christof, 21
Koestler, Arthur, 129, 243
Kool A. D., 220–1
Korzybski, Alfred, 326
Kovács, Agnes, 299
Krause, Wilhelm, 107
Kringelbach, Morten, 62
Kuhl, Patricia, 204, 283
- Kuhn, Gustav, 337
- Laennec, René, 13
Lancy, David, 242, 253, 256–7
Lange, Carl, 230
language, 290–316
ape language, 308–16
artificial grammars, 190–1
babies' first words, 300–8
and bilingual babies, 299, 307
'Clever Hans effect', 311–12
and deaf babies, 295
evolution and language learning,
314–16
evolution of music and language,
285–9
language games, 317–21
laughter precedes, 225, 228
and perceptual narrowing, 187
Speechome dataset, 303–4, 307
universal grammar, 313–14, 326
see also infant-directed speech;
prosody
language genes, 313–14
laughter, evolution of, 4, 223–8, 376
Laurel, Stan, 245
Le Jumeau de Kergaradec, Jean-
Alexandre, 13–14
Leach, Penelope, 50–1
Leakey, Mary, 196
Lehr, Jennifer, 126
lemurs, 64
leptin, 59
Leslie, Alan, 352–3, 355
l'Etang, Alain de, 295
Leuba, Clarence, 119, 124
Levakova, Lenka, 369
Lewis and colleagues, 145
Li Chi, 229
licking, 108, 112
Lister, Joseph, 26
literary theory, 273
Little Richard, 261
Locke, John, 158
Longhi, Elena, 289
Lopez, Jennifer, 261
Lorenz, Konrad, 39–40, 57, 165, 241,
327

THE LAUGHING BABY

- Luo, Yuyan, 350, 362
 Luther, Martin, 66
- macaque monkeys, 324
 McGhee, Paul, 246
 Mach, Ernst, 318
 McLaren, Malcolm, 260
 MacNeilage, Peter, 294
 McQueen, Steve, 260
 Mahajan, Neha, 363
 Mandler, Jean, 175
 mangabey, 63
 Mansbach, Adam, 98–9
 Mantle, Richard, 269
 Maori haka, 263
 Marcus, Gary, 324–6, 336
 Mareschal, Denis, 41, 43, 164, 170, 172, 176, 185, 189
 Markov blankets, 207, 210, 212, 376
 Martins, Luciana, 72–3
 Maslow, Abraham, 194
Matrix, The, 208–9, 212
 Maynard Keynes, John, 60, 319
 Meaney, Michael, 108–11, 237
 Mears, Oliver, 269
 Mehler, Jacques, 299
 Meissner corpuscles, 107
 Melhuish, Ted, 370
 Meltzoff, Andrew, 41–2, 204
 Mennella, Julie, 65
 mental health, 35, 57
 and sleep, 90–1
 Merkel's discs, 107
 methylation, 110, 112
 midwives, 26–9
 'milk-drunk' babies, 47–8, 59
 mind-body dualism, *see* Cartesian dualism
 Mindell, Jodi, 77, 94
 Mintz, Thomas, 117
 mirror neuron system, 358
 mirrors, 255–6
 Molyneux, William, 158
 Montaigne, Michel de, 337
 Montessori teachers, 195
 Moore, G. E., 318
 Moore, Keith, 41–2
 Moore, Sarah, 111
 morality, 359–60, 365
 Morgan, C. Lloyd, 122–3, 146, 231
 Moro reflex, 43
 Morton, John, 39–42
 mountain goats, 156
 Mozart, Wolfgang Amadeus, 267
 MRGPRB4+ neuron, 107
 Mumsnet, 75
 Murayama, Masanori, 147
 Murch, Simon, 50
 Murphy, Greg, 321
 music, 259–82
 babies' musical preferences, 277–82
 and dogs, 265–6
 and evolution, 264–5, 285–9
 foetal response to, 20–1
 Musical Rumpus, 270–2
 'musilanguage', 287, 289
- nappies, changing, 95–6
 Nash, Ogdon, 329
 nature–nurture (nativist–empiricist) debate, 40, 164, 200, 203, 354
 Navajo culture, 221–3, 227
 neurodiversity, 355
 Newburn, Mary, 26
 Newton, Isaac, 5, 161–2, 168–9
 Newton's cradle, 162
 Nietzsche, Friedrich, 259
 Nilsson, William, 240–1
 noggin, 31
 norepinephrine, 31–2
 nursery rhymes, 116, 134, 139, 220, 268, 279, 307
 Nüsslein-Volhard, Christiane, 196
- Oaksford, Mike, 335–6
 obesity, 49
 object permanence, 215
 observational comedy, 248
 obsessive-compulsive personality disorder (OCPD), 68
 Occam's razor, 122
 OCEAN personality dimensions, 347–8
 oestrogen, 13
 Oliveira, Cinthia, 72, 96
 Oller, Kimbrough, 284

Index

- Olsen, Calvin, 290
O'Meara, Ciara, 265
O'Neill, Daniela, 213
opera, 269
oral exploration of objects, 151–3
oral fixation, 68
orangutans, 37, 63, 119,
Orgs, Guido, 262–3
Oswald, Debra, 366, 371
Oswald, Ian, 79, 83
Oxford English Dictionary, 304
oxytocin, 13, 30–2, 34, 51–2
- Pacinan corpuscles, 107
Palmer, Zoe, 270–2
Pampers, 67, 72–4, 94–6, 265
Panksepp, Jaak, 120–4, 230–5, 237, 341
Parr, Ellen, 183
Pasteur, Louis, 26
Pavlov, Ivan, 40, 123
Pearl, Judea, 202, 207, 212
peekaboo, 213–21, 240, 255
Penn, Derek, 352, 357
perceptual narrowing, 187
Pfungst, Oskar, 311
phenomenology, 236
Piaget, Jean, 73, 192, 215
Piantadosi, Steve, 191, 252
Piazza, Elise, 282–3
Placebo, 260
placenta, 32, 34
Plato, 60, 175, 233–4
pleasure, 59–66, 195
Poincaré, Henri, 327
pointing, 353–4
pooping and weeing, 66–9
post-traumatic stress disorder (PTSD),
90
Potegal, Michael, 341–2
Pountney, David, 274
Povinelli, Daniel, 352
Pratchett, Terry, 249
pregnancy, 10–15, 103–4
see also foetal development
Premack and Woodruff, 352
premature babies, 104, 113, 284
preschool provision, 370–1
progesterone, 13
- Project Prakash, 158
prolactin, 31, 34
proprioception, 141–2
prosody, 287–9
Protungulatum donnae, 112
Provine, Robert, 128, 130, 134, 226, 375
psychoanalysis, 53–6, 68–9
psychoanalytic psychotherapists, 236–7
Pythagoras of Samos, 330–1
- quickenings, 11
Quine, Willard, 306
- Ramaswamy, Chitra, 10–11
Ramsey, Frank, 318–19, 335
rats, 80–1, 86, 101–2, 108–12, 120–4,
128, 146, 230–1, 311, 328
Rauscher and colleagues, 267
Rechtschaffen, Allan, 80
Reddy, Vasudevi, 228, 237–8, 242,
246–7, 255–6, 345–6
Rees, Sarah, 369
reflexes, in newborns, 43
Reissland, Nadja, 22, 45
relaxin, 31
rhythm, 261–2
Risley, Todd, 307
Rizzolatti, Giacomo, 356
Rocha, Sinead, 172, 261–2
Rochat, Philippe, 142
Rosch, Eleanor, 175
Rosling, Hans, 25
Rothbart, Mary, 246, 347
Roy, Deb, 303–4, 306–7
Royal College of Obstetricians and
Gynaecologists (RCOG), 18, 20,
23, 35
Ruffini corpuscles, 107
Rush, Michael, 374
Russell, Bertrand, 318, 325, 327
- Saffran, Jenny, 296–8, 325
St Augustine, 66
Saint Madeleine Sophie Barat, 178
Sally-Anne task, 354–5
Sanabria, Edgar Rey, 104
Savage-Rumbaugh, Sue, 313
Scarfe, N. V., 168

THE LAUGHING BABY

- schizophrenia, 134, 206
 Schmidt, Markus, 82–3
 Schopenhauer, Arthur, 243
 scientific thinking, John Dewey and,
 197–8
 secondary somatosensory cortex, 133
 Seinfeld, Jerry, 248
 Semmelweis, Ignaz, 25–6
 sense of self, 49, 101, 131, 134, 145, 255,
 345, 349, 357
 Sereno, Marty, 156
Sesame Street, 130–1, 146, 174, 269
 Shakespeare, William, 1, 119, 327
 Shaw, George Bernard, 269
 Shemella, Philip, 168–9
 Sherman, Lawrence, 226
 Shultz, Tom, 193
 simulation theory, 356–8
 Sinha, Pawan, 158
 Sirois, Sylvain, 189
 skin, 33, 104–7, 147
 Skinner, B. F., 309–11, 314
 sleep, 71–99
 Brazilian study, 72–4, 91–6
 and learning, 86–8
 metabolic theory, 82–3
 as overnight therapy, 89–90
 REM sleep, 80, 83, 85–6, 90, 94, 98
 restoration hypothesis, 79
 sleep-deprivation and death, 80–1
 and tablet use, 181
 and thermoregulation, 83
 see also dreams and dreaming
 smiles, 44–6
 Duchenne smiles, 44–5
 measuring, 193
 and pleasure, 63–4
 and sleep, 70–1
 and trapped wind, 9
 Smith, Adam, 61
 Smith, Linda, 159, 305
 Smith, Tim, 180, 182
 social group size, 224–5, 227
 Sonic Youth, 268
 Sophie the Giraffe, 178–9, 199
 soul, 7, 11, 143–4
South Park, 240
 Southery, Robert, 190
 Southgate, Vicky, 354
 Spelke, Elizabeth, 163–5, 215, 327
 Spencer, Herbert, 69, 244
 Spock, Dr Benjamin, 50
 Stahl, Aimee, 166
 statistical parametric mapping (SPM),
 205, 208
 Stewart, Lauren, 260–1, 265–6, 281
 still-face procedure, 239–40
 stochasticism, 194
 Stokoe, William, 312
 Strange Situation, 102
 Street, Sally, 252
 Striano, Tricia, 142
 Stumm, Sophie von, 49
 Sully, James, 246, 249
 Sure Start programme, 370
 Sutcliffe, Tom, 265, 269
 Swift, Taylor, 268, 276
 synapses, 83–4
 synchrony, 52, 220, 255, 263, 287, 350
 Szyf, Moshe, 109, 111
 TABLET project, 180–2
 tactile solipsism, 138
 Tagore, Rabindranath, 70–1, 99
 tantrums, 240–2
 Tardif, Twila, 301
 teaching, 253–4
 ‘technologress’, 234, 239
 teddy bears, 242
 Téglás, Ernő, 335–6
 teleological stance, 257
 Tempest, Kate, 260
 Tenenbaum, Josh, 203, 328, 336
 Terrace, Herbert, 310–12
 ‘terrible twos’, 342–3
 thalamus, 18–19
 theory of mind, 351–5, 357, 359
 theory theory, 200, 203
 Thomas, Dylan, 307–8
 Thomas, Elizabeth, 170
 thoracic nerve, 285
 thumb-sucking, 152
 tickling, 116–34
 as first joke, 128–30
 rats and, 123–4, 128
 robots and, 132–4

Index

- schizophrenics and, 134
- self-tickling, 131–4
 - as torture, 126
- Timberlake, Justin, 261, 264
- time perception, 170–4, 188
- Tinbergen, Niko, 40
- toes, 134–5, 138
- Tolstoy, Leo, 11
- Tononi, Giulio, 84
- Torschlusspanik*, 234
- touch, 100–15
 - affective touch, 106
 - infant massage, 112–15
 - orphan rats study, 108–10
 - skin and, 106–7
- touchscreen devices, 179–82
- TRACX, 298
- Trainor, Laurel, 267, 277
- Trehub, Sandra, 277
- Trevarthen, Colwyn, 228, 237–8,
254–5, 273, 345
- Tronick, Edward, 239
- Trump, Donald, 359
- Tsakiris, Manos, 357
- Turing, Alan, 325, 327

- ultrasound, 13–15, 17, 22, 45
- umbilical cord, 32, 48
- Utku Eskimos, 235

- Vallortigara, Giorgio, 165
- van der Meer, Audrey, 141, 146
- vestibular system, 141
- viability, legal definitions of, 11–12
- Victoria, Cesar, 49–50
- violation of expectation, 163–4, 337
- vision, 39–41, 153–60
 - in newborns, 39–41, 153–4, 159
- visual-cliff experiment, 155–6

- Vivaldi, Antonio, 264
- Vonnegut, Kurt, Jr, 359

- Walk, Richard, 155
- Walker, Arlene, 152
- Walker, Matthew, 90
- Walker, Sophia, 47–8
- Warneken, Felix, 364
- Wass, Sam, 220, 239, 270
- Wasserman, Ed, 324
- Watson, John, 214–16
- Watt Smith, Tiffany, 184, 228–9, 233,
239
- Weissbluth, Marc, 97
- Whitehead, A. N., 254
- Whitehead, Maisey, 150
- Wiesemann, Frank, 74
- Wilhelm, Ines, 88
- Williams, Liz, 275–6
- Williams, Pharrell, 277–8
- Williamson, Laila, 242
- Wills, Verna, 288
- Winnicott, Donald, 55–8, 210
- Wittgenstein, Ludwig, 5, 317–20, 322,
336, 356
- World Health Organisation (WHO),
25, 33, 49
- Wynn, Karen, 363

- Xu, Fei, 336

- Yankovic, ‘Weird Al’, 261
- Yoshida, Hanako, 159
- Yu, Chen, 305

- Zahn-Waxler, Carolyn, 361, 363
- ‘zone, being in the’, 194–5, 216
- Zotterman, Yngve, 127

A Note on the Author

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The extraordinary science behind what makes babies happy and why.

Long before they can talk babies can communicate their experience of the world through laughter and tears.

Dr Caspar Addyman is a developmental psychologist who, for four years, has run the Baby Laughter Project collecting data, videos and anecdotes from parents all over the world. He learned that laughter and smiles are of central importance at the start of life. They define a baby's cognitive and emotional development. Squeals of joy accompany all of a baby's little breakthroughs. Laughs and smiles connect them to their nearest and dearest.

The Laughing Baby is the culmination of Caspar's research and the story of infancy itself. The book moves chronologically through the first two years of life, looking at the physical, cognitive and emotional milestones in an infant's life and the smiles and laughs that accompany them. Understanding babies helps us understand ourselves. Babies provide the origin story for our incredible abilities. Along the way, you will learn the world's oldest joke, why music makes us happy, why babies find dogs funnier than cats and the origins of ticklishness...

Dr Caspar Addyman is a developmental psychologist. He is a lecturer at Goldsmiths, University of London, and previously spent a decade working at the world-renowned Birkbeck Babylab. Over four years he has surveyed thousands of families all over the world to find out just what makes their babies laugh. Caspar has undergraduate degrees in Mathematics (Cambridge) and Psychology (London) and a PhD in developmental psychology from Birkbeck. Before moving into academia he worked as chef and on financial trading floors. He lives in London.

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