3

Corrosive cortisol

> The nights were the worst. There were nights when, hearing him start at three or four in the morning, she would have welcomed anything that would let him stop and rest – paregoric, a sugar-tit, any of those wicked things. During her pregnancy, Priss had read a great deal about past mistakes in child rearing; according to the literature, they were the result not only of ignorance, but of sheer selfishness: a nurse or a mother who gave a child paregoric usually did it for her own peace of mind, not wanting to be bothered. For the doctors agreed it did not hurt a baby to cry; it only hurt grown-ups to listen to him. She supposed this was true. The nurses here wrote down every day on Stephen's chart how many hours he had cried, but neither Sloan nor Dr Turner turned a hair when they looked at that on the chart; all they cared about was the weight curve.
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> Mary McCarthy, *The Group*, 1963

Women send out messages like this from time to time, sometimes disguised in novels, sometimes in the first person – describing their experience of being alone with a baby day and night, with little adult company. The experience is often bleak, as the high incidence of 'post-natal depression' testifies; it is estimated to be suffered by one in ten new mothers. For them, there is a feeling of 'energy gone underground, flatness and grayness above ground; devastation, silence, withdrawal from life . . . How the baby perceives this withdrawal as the cloud moves over the sun, we can only guess' (Welburn 1980).

These days, we can do more than guess. There is a wealth of research which reveals a great deal about the experience of babies living with mothers who feel depressed or angry, almost always because they are insufficiently supported. Cut off from their usual sources of identity and support, these are stressed women. Yet they are expected to find the inner resources to manage a vulnerable newborn baby's delicate nervous system and to keep him or her free from stress. Unfortunately, when mothers themselves get so stressed that it becomes a struggle to cope with their babies, the baby's own capacity to cope with stress can be adversely affected. This chapter explains what important new research has to tell us about the development of the stress response in babyhood and how it can affect future emotional life.

The stressed brain

Stress is a word that we now use so casually that it has lost its impact. 'You're stressing me out' moans the teenager over the slightest disagreement with parents. Magazines offer quizzes to test your stress levels. Popular culture is awash with stories of exam stress, stressed executives, the stress of moving house. It would be easy to dismiss the whole concept as overblown psychobabble. Yet the way that we manage stress is actually at the heart of our mental health. It deserves to be taken very seriously indeed, but to do that, perhaps it would be helpful to focus less on the events that are thought to be stressful and to understand more about the internal factors involved in coping with stress.

In a sense, managing stress is the extreme end of emotional regulation. Stress is a state of high arousal that is proving difficult to manage, either because there is no respite or because the process of recovery isn't working. When experience proves to be too challenging, and threatens to overwhelm the normal homeostatic mechanisms, the body's stress response may come into play. The stress response is a particular cascade of chemical reactions that are triggered by the hypothalamus. One of its end products is a stress hormone called cortisol, which is proving to be a key player in our emotional lives. Scientists have discovered a great

deal about cortisol in recent years. Whilst the other biochemicals in the chain reaction are much more difficult to research, cortisol is relatively easy. Discovering that you can measure cortisol in the saliva, with much the same accuracy as a blood test, has been a boon to researchers. It is much easier to collect saliva samples throughout the day than blood samples and, as a result, many new studies of stress have been undertaken, looking at what causes stress and how active an individual's stress response is. These studies are underlining the importance of our biochemical responses in our emotional lives.

Every day of our lives, our internal biochemicals are fluctuating outside our awareness. All sorts of emotional and physiological responses are taking place automatically. Waves of hormones come and go through the day, adjusting and responding to events outside the body, or inside the body. They are involved in the daily rhythms of sleeping and waking, processing food, and keeping warm, mostly under the management of the hypothalamus in the core limbic area of the brain. These chemicals set off gene expression, changing behaviour in a way that will hopefully help the organism to maintain a good state. Serotonin helps us to relax, norepinephrine to be alert, whilst cortisol usually rises in the early morning to help generate energy for the day, and sinks to a low level in the late afternoon. These rhythmic flows of hormones are important to our daily moods. They impart particular qualities to experiences. Candace Pert suggests that these neuropeptides in the body are a kind of unconscious emotional vocabulary (Pert 1998) – particularly since each peptide rarely acts alone, but is combined with others into sentences. When we try to translate these body events into actual words, we may be trying to describe the complex chemical cocktail of the current moment.

All the major systems of the body are linked by this neuropeptide information, our 'chemical intelligence'. However, our scientific understanding of these biochemicals has developed relatively recently. In the 1950s, at about the same time that Watson and Crick were cracking the genetic code by unravelling the chemical structure of DNA, others were beginning to identify the chemical structure of hormones like insulin. In the 1970s, the particular hormones that have their main effects in the brain, called neurotransmitters, were discovered. Gradually more biochemicals with more general effects in the body began to be identified. So far, around 88 peptides have been identified. The process of identifying them carries on.

Since the brain plays a major role in monitoring experience and orchestrating responses to it, many of these biochemicals are concentrated there, particularly in the prefrontal cortex and the systems of the subcortex involved in emotion. One key part of the subcortical response to stress is the hypothalamus, situated in the centre of the brain. Although the hypothalamus is involved in a wide range of basic bodily activities, helping to maintain the daily regulatory rhythms, its remit is wider than this. It also plays a key role in dealing with any stressful experiences that overload the system and upset these regulatory routines. In particular, the hypothalamus can be activated by neurochemical messages from the amygdala, which reacts to social situations that generate uncertainty or fear by firing off chemical messages in various directions (Figure 3.1.)

In response, the hypothalamus then triggers what is known as the stress response, described by scientists as the HPA axis (hypothalamus triggers pituitary which in turn triggers the adrenal glands). The end result is that the adrenal glands generate extra cortisol, to generate extra energy to focus on the stress and to put other bodily systems on "hold" whilst this is being dealt with.

Bill's divorce

One of the major stressors, by common agreement, is divorce. When Bill, a solid middle-aged man with a sophisticated intelligence and pleasant manner, came to see me for the first time, he struggled not to cry. He told me his situation. Caroline and Bill had been a much envied couple for 20 years. Attractive and sociable, their parties were legendary. They always seemed so mutually supportive and had both built up glittering careers in different fields of journalism.

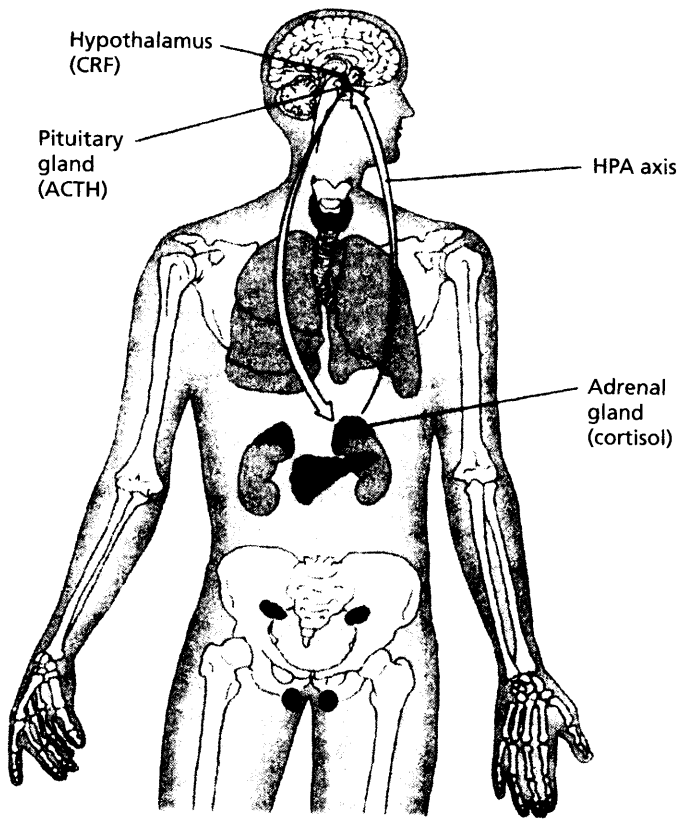

Figure 3.1 **Each of the glands produces and releases hormones into the bloodstream. The arrow shows the hypothalamic pituitary adrenal (HPA) axis, which controls the release of the stress hormone cortisol.**

But suddenly they had shocked their friends and colleagues by separating. It transpired that Caroline had been having an affair with a younger man for several months.

Bill had come for psychotherapy to try to manage his complicated feelings. He revealed that in fact he had not felt close to Caroline for years. He felt that she only ever wanted to talk about work, and he could never get her to deal with the minor conflicts that arose between them. She would tell

him how much she loved him and reassure him that everything was fine, yet he never felt his concerns were addressed; he felt palmed off by her 'niceness'. Yet discovering the affair was a terrible shock to Bill and had made him feel physically ill. He had always believed that Caroline was such a reliable, sensible person who always acted responsibly. He couldn't take in the change in his perception of her. Worse still, she had fallen madly in love with someone he despised – a charmer who lived off his inheritance, gambled and partied, and had five children by different wives.

Bill was suffering from one of the worst stresses known to humans – the loss of an attachment relationship. He was in pain. He had difficulty sleeping and he didn't feel like eating. He didn't know what to do; one minute he was thinking up ways of getting Caroline back, the next he was dreaming of burning down her lover's flat with her in it. Even though, as it happens, Caroline and Bill did not regulate each other's feelings very well, he was desperately afraid of being alone, afraid of never being loved again, and having no one there for him at all. He no longer felt secure.

Inside Bill's body

The uncertainty and fear of Bill's situation has triggered off his stress response via his amygdala. His hypothalamus is doing overtime, struggling to keep his systems in balance. It has sent out a message to provide extra energy for Bill to meet this crisis in his life by producing extra cortisol. This message goes in stages, first in the form of corticotropin-releasing factor (CRF) to the pituitary, which in turn produces adrenocorticotropic hormone (ACTH), which then triggers the adrenal glands to produce cortisol.

As soon as the cortisol level rises in Bill's body, it starts to communicate with a whole range of his body systems. The cortisol puts brakes on his immune system, his capacity to learn, his ability to relax. In effect, the cortisol is having an internal conversation with other bodily systems which goes a bit like this: Cortisol: 'Stop what you're doing, guys! This is an emergency! Don't waste time fighting bugs. Don't waste time learning or connecting new pathways. Don't relax! I

want all your attention on this problem.' This is useful as a short-term expedient. The cortisol breaks down fat and protein to generate extra energy and puts other systems on hold, temporarily. When the situation is over, the cortisol is gradually reabsorbed into its receptors or dispersed by enzymes. The body returns to normal.

But if the stress persists, and high levels of cortisol remain in the body over a longer period of time, then it can begin to have a damaging effect on other parts of the body. It can affect the lymphocytes of the immune system, making them less responsive, or even killing them off and stopping new ones from forming (Martin 1997).

In the brain, it can particularly affect the hippocampus. Although at first cortisol has a useful function in an emergency, activating defensive behaviour such as freezing the body's movement (which is co-ordinated by the hippocampus), it is less helpful as time goes on. If the level of cortisol remains high, the receptors for cortisol can close down and make the hippocampus less sensitive to cortisol, and less able to provide important feedback to the hypothalamus to tell it when to stop making more cortisol. Normally, the hippocampus informs the hypothalamus that a certain level has been reached and no more is needed. Hippocampus: 'I'm drowning in this stuff, please stop pumping it out. I've had enough cortisol.'

Without this feedback, the stress response can get stuck in the 'on' position. This can be a real problem for the hippocampus because if the cortisol continues, it can actually damage the hippocampus. The effect of too much cortisol can be to let too much glutamate get to the hippocampus, starting a process of neuron loss (Mogghadam *et al.* 1994). Eventually, the hippocampus may start to malfunction. If the stress goes on for a very long period, Bill might start to get forgetful, as the hippocampus is central to learning and memory. As the saying goes 'Stress makes you stupid' (Chambers *et al.* 1999; McEwen 1999).

But the amygdala gets a buzz from all this cortisol. It gets more and more revved up and excited by the cortisol, and keeps releasing norepinephrine which itself triggers yet more cortisol production (Makino *et al.* 1994, Vyas *et al.* 2002). In effect, the amygdala is an over-excited child with somewhat primitive reactions. Amygdala: 'This is such a bad situation! I must remember this and next time I see someone lying to me, like Caroline did to Bill, I will be in there like a shot!'

Only the medial prefrontal cortex, particularly the anterior cingulate, has the ability to control or override the amygdala. But the longer the stress continues, the more the neurotransmitters that normally power the prefrontal cortex are affected. Dopamine and serotonin levels fall there. Cells may also eventually start to die there.

The prefrontal cortex says wearily: 'I just can't cope with these organs. They are too hyped up. I can't stop them. I just don't have the strength. I'd better keep away from people, I can't deal with them right now.'

The sensitive nervous system

If these are the effects of stress on Bill's adult brain, consider what impact stress might have on a developing brain. How would stress affect the baby's hippocampus, prefrontal cortex and stress response? Just as the brain is customised by specific local experience and culture, so too are its biochemical systems, including the stress response. Like a car or a house, each individual is a system with basic features in common with other individual bodies, but also with its own history and peculiarities. Just as my home has rather poor plumbing and a tendency to leak, so too one individual might have many such 'tendencies': to have a weaker or stronger bladder than others, to react to the slightest difficulty with great anxiety, or to sail through life with confidence.

We tend to think of these human differences as genetic. It is hard to shake off the mechanical idea of the body as something which develops like clockwork to the dictation of genetic programmes, particularly our physiological responses which appear to be so automatic. We are not accustomed to thinking of these as socially influenced, particularly by the quality of our early relationships which may seem a sloppy and unscientific notion.

Yet the picture emerging in modern science is that genes provide us with raw ingredients for a mind – and each one of us comes with slightly different ingredients – but the cooking, particularly in infancy, is what matters. Even as genes are identified and linked to various human difficulties, the links are demonstrated over and over again to be necessary but not sufficient. In other words, there may be a genetic predisposition to depression, schizophrenia, obesity or other ills, yet it is impossible to say that these genes 'cause' the malfunction. Most genes are expressed in response to environmental triggers and in combination with each other. In early life, 'environment' mostly consists of the human beings who take care of us.

With the human nervous system, the very early stages of cooking make all the difference. Things can go wrong in many ways. A lack of good nutrition in the womb, a lack of oxygen during birth, or a lack of emotional support in infancy – all can have a tremendous impact on the assembling and developing organism. Early care actually shapes the developing nervous system and determines how stress is interpreted and responded to in the future.

One way of putting this is to say that the kinds of emotional experience that the baby has with his caregivers are 'biologically embedded' (Hertzman 1997). They get written into the child's physiology because this is the period of human life when regulatory habits are being formed. This is when our automatic emotional and physiological responses are set up in the brain. Although we do remain open systems and can still change our habits, it is also true to say that as we get older our internal systems stabilise and become relatively fixed. As anyone who has tried to create new eating habits or to change themselves emotionally knows, it is an uphill struggle to create new regulatory habits. It is hard to remember to behave differently and it takes a long time before new ways of doing things become automatic. Compared to that, infancy is an incredibly open period of life in which change can happen very rapidly.

In particular, these early experiences set up physiological expectations as to what our 'normal' levels of biochemicals are. In this way, they affect our baseline levels of

serotonin or cortisol or norepinephrine, and the 'set point' that our body regards as its normal state. They will also affect the amounts of chemical we produce in response to particular situations. Stress in infancy – such as consistently being ignored when you cry – is particularly hazardous because high levels of cortisol in the early months of life can also affect the development of other neurotransmitter systems whose pathways are still being established. They are still immature and are not fully developed even by weaning time (Collins and Depue 1992; Konyescsni and Rogeness 1998). Babies of withdrawn mothers, for example, have lower norepinephrine, epinephrine and dopamine than other babies (Jones *et al.* 1997). When stressed, these various biochemical systems may become skewed in ways that make it more difficult for the individual to regulate himself in later life.

Human babies are born with the expectation of having stress managed for them. They tend to have low levels of cortisol for the first few months, as long as caring adults maintain their equilibrium through touch, stroking, feeding and rocking (Hofer 1995; Levine 2001). But their immature systems are also very unstable and reactive; they can be plunged into very high cortisol levels if there is no one responding to them (Gunnar and Donzella 2002). Babies cannot manage their own cortisol.

Gradually, however, they get used to distressing situations once they are confident that they will be managed by an adult caregiver, and cortisol is less easily triggered off (Gunnar and Donzella 2002). Once their sleeping patterns become more stable, between about 3 and 6 months of age, the normal rhythm of an early morning peak in cortisol as the baby wakes is established. However, it takes most of early childhood (until around 4 years old) to establish an adult pattern of high cortisol in the morning and low cortisol towards the end of the day.

There is still great confusion about how to manage distress in small babies. Not picking up a baby and leaving him or her to 'cry it out', as in the quote at the beginning of this chapter, is still common practice. Such distress is probably inevitable from time to time, but as a regular way of

managing a baby it leaves a lot to be desired. A baby whose stress (and therefore cortisol) is not kept at a manageable level may eventually be seriously affected. There is some evidence to suggest that high levels of cortisol might be toxic to the developing brain over time. In particular, too much cortisol can affect the development of the orbitofrontal part of the prefrontal cortex (Lyons *et al.* 2000a) – an area which as we have seen is responsible for reading social cues and adapting behaviour to social norms. Maternally deprived rats have been found to have reduced connections in this area of the brain.

The hippocampus may also be particularly affected by early stress. With too much cortisol at a sensitive time of development, the number of cortisol receptors in the hippocampus can be reduced (Caldji *et al.* 2000). This means that when cortisol levels rise under future stress, there are fewer receptors to receive it and the cortisol can flood the hippocampus, affecting its growth. On the other hand, those who are touched and held a great deal in babyhood, who receive plenty of attention in early life, have been found to have an abundance of cortisol receptors in the hippocampus in adulthood. This means that they can cope more easily with the cortisol triggered by stress; when its level rises, there is somewhere for it to go.

Stress shapes the stress response

Essentially, the stress response system is affected by how much early stress it has to deal with, and how well the system is helped to recover. It seems that what you put in to the system is what you get out – a well-resourced and well-regulated infant becomes a child and adult who can regulate himself or herself well, whilst a poorly resourced and poorly regulated infant becomes a child who cannot regulate herself well. The way that Bill, for example, manages his crisis will be influenced in part by the robustness or otherwise of his stress response.

If he is a 'high reactor' to stress, he will produce a lot of cortisol at the least provocation. He may be easily depressed, easily panicked and prone to overeating. Without

Caroline, he may fall into depression and put on weight. These types of stress response systems have been linked to having had less than optimum early mothering, with an inexperienced or depressed mother, or an unpredictable mother, who is sometimes available and sometimes not.

On the other hand, if he is a 'low reactor', he may have a flattened cortisol response. He may give the impression to his colleagues that he is coping, appearing not to have a strong reaction, but they may be surprised to see his occasional outbursts of aggression. This stress response is more often linked to having grown up in conditions of more or less continuous emotional unavailability. This may equally result from a parental 'stiff upper lip', or from more overtly hostile parents who used physical punishment to curb their son's emotions. At the extreme, this state may be found in orphans.

Nature or nurture?

But the baby's vulnerability to mishandling can start even earlier, in the womb. Even at this stage, it is the elements of the brain responsible for responding to stress which are amongst the most vulnerable parts of the brain. As early as pregnancy, the stress response is already forming within the developing foetus and can be affected by the mother's state of health. In particular, her high cortisol could pass through the placenta into his brain (Gitau *et al.* 2001a), potentially affecting his hypothalamus and hippocampus. One animal study even found that exposing a foetus to high levels of cortisol produced adults who were hypertensive (Dodic *et al.* 1999). It is not really surprising that the foetus is so vulnerable to the mother's state of mind and body, since her body is temporarily the body of the foetus. Her dietary deficiencies and her stress levels become his. This means that she can pass on – by non-genetic means – her own oversensitised stress response to her baby.

The mother's use of drugs can also have a big impact on the unborn foetus. Mothers who drink a lot of alcohol in pregnancy can raise the cortisol level of their unborn babies, and there is some evidence that these children will have an

overreactive stress response that lasts into adulthood (Wand *et al.* 2001). Smoking during pregnancy not only affects growth, but has also been found to affect a baby's behaviour, making it swing between fussiness and indifference (Kelmanson *et al.* 2002). Then again, birth itself can also be traumatic for a baby. A difficult forceps delivery raises the baby's cortisol levels in a way that neither normal nor Caesarian delivery do (Gitau *et al.* 2001b).

Babies exposed to these sorts of experiences in the womb are more likely to appear to be 'difficult' from the start. Of course, some babies are also born with a more sensitive temperament for genetic reasons. There is currently a broad consensus that babies' temperaments differ and that some are more temperamentally demanding than others. Although there are more subtle ways of describing temperament, the broadest categories describe two main types: the less reactive and the highly reactive baby. The reactive baby (thought to make up about 15 per cent of babies) possibly has more sensitive sensory equipment; he cries more and tends to be more timid and fearful because he is easily overwhelmed by stimuli. Interestingly, these children also tend to have narrow faces, according to Kagan (1999), suggesting some genetic linkage.

Whether highly reactive or super-sensitive because of temperament or pre-natal experience, such babies are more easily stressed and need very good parental management to keep them free of stress. They need more than average amounts of soothing and calming, through being held and fed frequently, to restore their systems to normal responsiveness. Since this is more difficult for their parents than dealing with an 'easy' baby, many of these super-sensitives will find their stress systems getting overloaded and may end up with an overreactive system, high baseline cortisol and a risk of emotional insecurity.

This modern view of temperament, focused on the sensitivity or robustness of the baby, is rather different from the classical psychoanalytic understanding of children, whose focus was on children's different levels of sexual and aggressive 'drive'. In Freudian theory, the strength or weakness of these drives was thought to make them more or

less prone to neurosis. Early psychoanalysts tended to focus on how the individual child got through the different stages of early development; problems arose through becoming 'fixated' at the oral or anal stage. Although this approach recognised the importance of early experience in later outcomes, it did not adequately recognise how parents and other adult caregivers might be affecting their developing child. It was not until after the Second World War that psychotherapists shifted their emphasis to the actual interactions between people and began to focus more boldly on the links between the experience of harsh, unpredictable or neglectful early parenting and later emotional difficulties. Subsequent research has indeed confirmed that parenting, at least as much as genes and innate factors, determines many outcomes.

For example, there is a strain of rats that is genetically predisposed to being more fearful than other strains of rat. Left with their biological mothers, these rat pups tend to be fearful and easily stressed. But when experimenters placed them for 'adoption' with non-fearful rat mothers, they found that these baby rats grew up without fear. Clearly, whatever the genetic tendency might be, it was the rearing that mattered (Francis *et al.* 1997). Similarly, rats from a 'low aggression' strain became aggressive when they were fostered to 'high aggression' foster mothers and vice versa (Flandera and Novakova 1974). But is the same true of humans?

Take a group of temperamentally reactive babies. Their genes appear to have destined them to be super-sensitive to stress. They are the whingers of the world, the crying babies who become neurotic adults. Indeed, research has confirmed that left to themselves they do tend to end up with insecure attachment to their mothers. However, the Dutch researcher Dymphna Van den Boom did not leave it at that. She wanted to find out if their mothers could learn to manage them in a way which calmed their stress. To this end, she designed a form of short-term instruction and support for mothers of sensitive babies which aimed to help the mothers to respond better to them. With this help, most of these more difficult babies did indeed grow up with secure attachments (Van den Boom 1994).

This kind of work makes a strong case that temperament does not determine outcomes. Emotional security depends much more on the kind of care that babies receive, and whether or not parents can rise to the challenge of meeting the needs of their more demanding babies. As attachment researchers have always pointed out, secure emotional attachments are after all the product of a relationship, not of an individual temperament

What is stress for a baby?

Most of us have an idea of what stress is for adults, perhaps associated with working long hours and trying to do too much, under pressure to achieve; or it may also be associated with the pressures of 24-hour-a-day parenting without sleep or respite; or with the struggle to keep afloat in conditions of poverty and violence. What these ideas of stress have in common is that stress is about being overwhelmed, lacking sufficient resources to meet the demands life places on you or trying to survive in particular environments without sufficient support from other people. This is the adult version of stress. But what does it mean in babyhood?

For babies, stress is probably much more to do with sheer physical survival. Babies' resources are so limited that they cannot keep themselves alive, so it is very stressful for them if the mother is not there or does not respond quickly, providing the milk, warmth or feeling of safety they need. When these needs are not met by others, the baby may become more aware of a sense of powerlessness and helplessness. Stress for babies may even have the quality of trauma. Without the parent's help, they could in fact die. In newborn babies, the stress response can be generated by physical danger such as a forceps delivery or circumcision (Gunnar *et al.* 1985a, 1985b), confirming its usefulness as a way of meeting sudden threats to bodily integrity and the need for survival.

A baby's cries of mental pain when distressed also presumably have an important function. They successfully create stress for the parent in turn, cutting through the parent's dangerous inattention, to ensure a response – and

with it the baby's survival. In adulthood, we still use our stress response in situations that threaten our physical survival, like accidents, surgery or assaults. But in our less physically dangerous modern environments, the stress response is probably more often triggered by psychological threats. We are more likely to be stressed by losing a promotion or being caught with a prostitute than by being stalked by a tiger. This makes sense when we consider that in modern societies survival depends on social acceptance and social status; it is very stressful when these things are at stake.

In human society, there is a kind of stock exchange of the emotions of which cortisol seems to be a by-product. The more your social stock goes up, the more your cortisol comes down. Conversely, when your social stock goes down, your cortisol level will rise. Robert Sapolsky's work with baboons showed that the more social power you have, the less cortisol you have. Top baboons have low cortisol, whilst low-ranking baboons have high cortisol (Sapolsky 1995). We can see this most clearly in human society in the vicissitudes of emotional life in primary schools. When your young son or daughter experiences a painful demotion in a friendship, saying 'he was horrid to me, I hate him' one week, then rushes home in exhilaration saying 'he's my best friend' the next, we glimpse the process starkly. (Adults are perhaps better at hiding it, as well as better at managing these ups and downs.)

Dangerous stress

Stress that comes and goes is the condition of life. But what really damages your mental and physical health is not passing periods of stress for a few hours or days, but persistent powerlessness and unrelieved, chronic stress. Short-term stress that is clearly over when the crisis has passed, allows you to restore your internal systems to their normal state and does little harm. In fact, often people feel that a little stress is stimulating. But when you have to spend months or years worrying about your pension or your neighbour's loud parties, being unable to get the job you want or the partner you need, anxiety and helplessness at

being unable to do anything about it can undermine your health.

To a large extent, stress is generated by what is unpredictable or uncontrollable. If you don't have the power to avoid a negative outcome or the power to get something you need, this is very stressful. For example, people who cannot get the treatment they need for an illness will be under extreme stress. On the other hand, it seems that people who are actually in the process of dying generate very little cortisol despite the threat to their body systems. Perhaps the slow decline of physical systems is accepted by this stage and no longer meets resistance and stress. But situations that are unpredictable, which take you unawares, which you want to resist but have little power to change, are the defining characteristics of stress. From this point of view, it is clear that babyhood can be extremely stressful without the support of tender, protective parenting.

Many sources of stress can be managed if there are resources to meet the challenge. If you are wealthy and have access to a team of lawyers and advisors, you may cope better with a pensions fraud than those who have no savings and little higher education. The same goes for inner resources – with enough inner confidence, many situations can be dealt with. The evidence is also that it makes a great deal of difference if the individual is supported by secure social bonds. With a network of support, stress may be manageable, whether in infancy or in adulthood. Recent crucial evidence has shown that children with secure attachments do not release high levels of cortisol under stress, whereas insecure children do (Gunnar and Nelson 1994; Gunnar *et al.* 1996; Nachmias *et al.* 1996; Essex *et al.* 2002). There is a powerful link between emotional insecurity and cortisol dysfunction. So it is not necessarily the nature of the stress that matters, but the availability of others to help manage it, as well as the inner resources of the person experiencing it.

These inner resources are not always obvious. Researchers expected to find that children with rather timid, fearful temperaments would have high cortisol levels under stress, but this turned out not to be the case. They actually had normal cortisol levels under stress unless they were also

insecurely attached to their parents. On the other hand, children who appeared on the surface to be cool and collected did have high cortisol levels under stress because they too turned out to be insecurely attached. It was the insecure attachment that mattered, not the personality style or 'persona', which is not always a reliable guide to inner emotional resources. By 1 year old, children who are in secure relationships that respond to their needs and regulate them well are unlikely to produce high levels of cortisol even when they are upset, whereas those in insecure relationships do. The key feature of insecure attachment is a lack of confidence in others' emotional availability and support.

Separation and dysregulation

Probably the most stressful experience of all for a baby or toddler is to be separated from his or her mother or caregiver, the person who is supposed to keep him or her alive. Early separation from the mother increases corticotropin-releasing factor (CRF) in the amygdala. This is thought, by some, to be the biochemical of fear, suggesting that even short separations from the source of food and protection are very frightening for any breastfed young mammals, including humans.

There is strong evidence that separation from those on whom we depend raises cortisol. Studies on both monkeys and rats have found strong correlations between early separations from the mother and high cortisol levels. Each time a baby squirrel monkey is separated from his mother, his cortisol goes up. If this happens repeatedly, even for only five hours a week, his cortisol feedback sensitivity increases. He becomes more clingy and easily distressed and plays less (Plotsky and Meaney 1993; Dettling *et al.* 2002).

Social conflict and threats from predators also raised cortisol levels. Primate studies have shown that cortisol levels rise when an individual is under threat from others in the group, in conflict with another member of the group, or cut off from the social group in some way, as well as more obvious episodes of physical separation from the mother in

infancy. So it seems as if cortisol in general is a by-product of an anxiety about safety, survival and the social bonds which protect.

Recent work has linked these findings more directly to humans. In modern societies where women can potentially enjoy a variety of roles, children are increasingly separated from their mothers to enable them to go out to work. But arguments have raged for decades about the impact this has on their children. Andrea Dettling, a researcher in the USA, used cortisol as a way to measure the effect on their stress response. She went to an all-day nursery to study 3- and 4-year-old children who were separated from their attachment figures all day. What she found confirmed the fears of some mothers that their children do indeed find the experience stressful. They did not necessarily look stressed or behave as if they were stressed, but their stress response was activated and their cortisol levels rose as the day wore on, especially if they were children with poor social skills. By the afternoon, their cortisol was extra high – at a time of day when it was normally sinking in children at home with a parent (Dettling *et al.* 1999).

However, before leaping to conclusions about nursery care, Dettling pursued the question further and found that high stress levels were not an inevitable consequence of substitute childcare. In a second study, she focused on children who were separated all day from their attachment figures, but were placed with childminders. She found that what really mattered was the quality of the replacement caregiving and whether there was someone really paying attention to the child. Children who were placed with childminders who were highly responsive to them had normal cortisol levels (Dettling *et al.* 2000).

These findings strongly support the importance of emotional regulation and the absolute necessity for small children of having someone continuously available who notices your feelings and can help you regulate them. Her findings suggest that this person does not have to be a mother or a father, at least by the age of 3, as long as he or she is tuned in and emotionally available to the child. On the other hand, her studies do suggest that it is the lack of this consistent responsiveness and protection that is the mark of stress for a dependent child.

Stressed parent, stressed child

Sometimes, of course, it is not the mother's absence that is the problem for the child, but the quality of her presence. Even if children are at home with their biological parents, they may still be poorly regulated. For example, children of alcoholic parents have high levels of cortisol, probably as a result of having parents who may be physically present, but mentally unavailable to provide consistent regulation (Jackson *et al.* 1999).

Mothers who are themselves under stress are likely to have more difficulty in regulating their babies well. This was clearly demonstrated in primate studies of monkeys subjected to conditions where they did not know where the next meal was coming from. Known as 'unpredictable foraging', this turned out to be much more stressful for both mother and her offspring than conditions of consistently little food being available (Rosenblum *et al.* 1994). But having a stressed mother had a big effect on her offspring. The young monkeys themselves had high corticosteroids and high norepinephrine. We might imagine that a mother who is worrying about where the next meal is coming from would be less likely to be focused on the regulation of her offspring. As a result, the infants themselves couldn't relax. They too had to stay alert and anxious. These monkeys ended up behaving in a depressed fashion. It is not hard to imagine that human parents coping with unpredictable conditions of life, particularly those living in low social and economic strata, will experience similar responses.

It is ironical that our modern way of life itself involves putting the chief carers of babies under enormous stress themselves. Rachel Cusk describes the contradictions well:

> To be a mother I must leave the telephone unanswered, work undone, arrangements unmet. To be myself I must let the baby cry, must forestall her hunger or leave her for

evenings out, must forget her in order to think about other things. To succeed in being one means to fail at being the other. (Cusk 2001: 57)

The most painful aspect of the situation seems to be the isolation coupled with total responsibility. She feels like 'a deserted settlement, an abandoned building in which a rotten timber occasionally breaks and comes crashing to the floor' – an image far from the earth mother of popular fantasy whose abundant breasts and maternal love will soothe her baby's every stress. As a result, both mother and baby are caught in the same trap, both lacking the support that they need to manage their stress.

Whilst animal research has well documented the impact of early stress (such as repeated brief separations from the mother) on the infant's developing systems – such as a highly reactive stress response, together with a lifelong tendency towards anxiety, depression and loss of pleasure (Francis *et al.* 1997; Sanchez *et al.* 2001) – the links to human behaviour have remained somewhat speculative. But one recent study has provided the first direct evidence that humans as well as other animals are equally vulnerable to the effects of a stressful early environment. This study, undertaken by Marilyn Essex and her colleagues at the University of Wisconsin (Essex *et al.* 2002), was a convincingly rigorous, 'prospective' study. Based on a large sample of 570 families, it followed them all the way through from pregnancy to age 5 years. This substantial piece of work provided clear evidence that the experience you have as a baby predicts your later responses to stress.

When she measured the stress levels of children at the age of four and a half, she found that those who were currently living with stressed mothers had high cortisol, but only if their mothers had also been under stress or depressed when they were infants. In other words, they were only vulnerable if a difficult babyhood had affected their developing stress response or HPA axis. These children would be liable to produce more cortisol under pressure than other children who had experienced an easier babyhood. As they went through childhood, they had been left with a legacy from the

early tensions in their relationship with their mothers – a tendency to react more strongly to difficulties in life. (Such vulnerable children don't have a constantly high level of cortisol. Whilst there was no current stress, their level of cortisol was not raised.) Other recent research has found that children like these, whose stress response is compromised by a mother's depression during their infancy and who live with subsequent episodes of depression, are also at risk for later violent behaviour (Hay *et al.* 2003).

Work with Romanian orphans has shown that there may even be a critical period during which the HPA stress response system is being set up. Babies from these orphanages who were adopted after the age of 4 months continued to have high levels of cortisol, even when they were adopted, whilst those who were adopted before the age of 4 months seemed able to regain a normal stress response (Chisholm *et al.* 1995; Gunnar *et al.* 2001). Although this may have something to do with the mother's ability to bond more easily with a younger baby, there is other evidence to suggest that the HPA system adopts its 'set point' by the age of 6 months. During the earliest months, the cortisol response is variable, but after that age it seems to stabilise and remain consistent (Lewis and Ramsay 1995). This emphasises once again the particular vulnerability of that earliest foetal and infant period, when stress can be most toxic to the developing organism.

Highs and lows of cortisol

There are clear links between an individual's psychological coping strategies and his or her physiological coping strategies. Both are established in infancy and toddlerhood and tend to persist through life. Both are developed in response to the child's earliest relationships. As I have already outlined, secure early relationships are characterised by the presence of consistently responsive adults who seem to enable the child to organise himself or herself well, to be able to use others to help regulate stress when necessary, and in the process, to maintain a normal level of cortisol. However, insecure early relationships are more

variable. They diverge in two broad directions: towards high emotional reactivity or low reactivity. A child who isn't feeling well regulated will normally be aroused and reacting, generating stress hormones such as cortisol. But, as I will describe shortly, sometimes an 'anti-arousal' mechanism will come into play if the child is under prolonged stress.

High cortisol

Children who are described in the attachment literature as 'resistantly' attached tend to dramatise their emotions. They do this in response to parents who are inconsistently emotionally available – whether distracted, absent-minded, busy, or frequently absent. They try to capture the parent's attention by amplifying them. But they never quite know if she will notice them or if they can get the comfort they need when they need it. Since unpredictability is one of the main factors which generates high cortisol, it seems probable that these may also be children with high cortisol levels. Certainly one study found these types of children to be the most fearful during infancy and toddlerhood (Kochanska 2001) and cortisol and CRF are the hormones of fear. However, there is little hard evidence that their cortisol levels are significantly high in this period. More research is needed to establish whether there are links or not.

High cortisol levels are linked to relatively high activity in the right frontal brain, the part of the brain which generates fearfulness, irritability and withdrawal from others (Davidson and Fox 1992; Kalin *et al.* 1998b). The right frontal area is specialised for processing stimuli which are novel and distracting, and it seems likely that children with an activated right hemisphere will be constantly on the alert. They may be children who live with unpredictable or unreliable caregivers who are driven to be emotionally vigilant and watchful as they attempt to read the parent's non-verbal signals.

We know that there are strong links between high cortisol and many emotional dysfunctions such as depression, anxiety and suicidal tendencies in adulthood, as well as with eating disorders, alcoholism, obesity and sexual abuse

(Colomina *et al.* 1997). Some of these links will be explored in subsequent chapters. But high cortisol is not only implicated in psychological problems, it is also damaging to the body's systems. As Schulkin and Rosen put it, too much fear is 'metabolically costly' (Schulkin and Rosen 1998: 150). It can damage the hippocampus and capacity to retrieve information (perhaps making an 'absent-minded' or 'scatty' child), as well as affecting the ability of the prefrontal cortex to think and manage behaviour (Lyons *et al.* 2000b). It compromises the immune responses, making the individual vulnerable to infection; it compromises wound healing and even in some cases leads to decrease in muscle mass and to osteoporosis. It may play a part in diabetes and hypertension through increased blood glucose and insulin levels (which can also lead to overweight and fat tummies). The stress response is such an essential part of our organism's response to life that it appears to underlie an astonishing range of disorders. When it does not function well, we become vulnerable both physiologically and psychologically.

The mystery of low cortisol

But just as we are getting the measure of high cortisol and its impact on our lives, I must present another twist in the story. In some people, an unusually low baseline level of cortisol can be found, which is also linked with disorders of various kinds. This phenomenon of low cortisol is still somewhat mysterious. It is not yet fully understood, but is much more common than researchers thought, particularly in early childhood (Gunnar and Vazquez 2001). It is fairly clear that a child under stress will react with high cortisol. So why do some people have a consistently low baseline level of cortisol? One account is that if an organism experiences continuously high cortisol for a prolonged period, it will eventually react by closing down cortisol receptors. This is known as 'down regulation'. The physiological mechanisms involved in this phenomenon are not fully understood as yet, but researchers speculate that this is one way that the body deals with a prolonged exposure to cortisol (Heim *et al.* 2000).

The switch into low cortisol mode also appears to be a kind of defence mechanism. It is an attempt at disengagement from painful feelings through avoidance, withdrawal and denial of painful experience (Mason *et al.* 2001); better to feel nothing than to cope with relatively continuous painful experience. But this (unconscious) strategy can produce a state of emotional numbness, and even dissociation (Flack *et al.* 2000), which can make people feel empty and alienated from other people. Children in this state go down a route of passive coping, which can make them less able to respond when they need to. For example, one study of children at a nursery school found that those with low baseline cortisol did not react to a highly stressful day by producing cortisol (Dettling *et al.* 1999). By some means, such a child is managing to deny the impact of painful or stressful events even to the extent of switching off his stress response. Unfortunately this may switch off feelings in general. These children may be less responsive to happy stimuli too, although they may often put on a cheerful face with 'overbright affect' (Ciccetti 1994).

Low cortisol has been associated with low grade, frequent emotional (and sometimes physical) abuse and neglect. However, timing may be important. The age at which these experiences happen may be crucial in producing this low cortisol phenomenon. Andrea Dettling's most recent research with marmosets (who are primates like us) has found that only the monkeys who were separated from their mothers in very early life (for up to two hours a day) developed low cortisol baselines. Their twin siblings, who had not been separated, didn't develop a low cortisol baseline, and nor did slightly older, semi-independent infant monkeys in another study (Dettling *et al.* 2002). Researchers continue to clarify the circumstances and timing which give rise to the low cortisol phenomenon, but very early neglect or deprivation of some kind do seem to be implicated.

There may well be overlaps with the category of avoidant attachment, too, although there is no clear evidence as yet. Children tend to develop an emotionally avoidant style of relating when they experience negative attitudes towards them which may develop into hostility and criticism, or

intrusive parenting which does not respect their boundaries. In return, these children feel angry, yet they live in a family culture which does not tolerate the child's self-expression, so find themselves obliged to suppress their own negative feelings. Unfortunately, suppressing feelings doesn't make them go away; in fact, it may actually increase arousal (Gross and Levenson 1993). This may be why such feelings eventually tend to burst out uncontrollably and unpredictably. Suppressed aggression may be stored until a relatively safe outlet is found which triggers its release. In children, it is often released with their peer group rather than with the parents who upset them in the first place.

It may seem paradoxical that the most destructive children are those who try to suppress their feelings. But the most aggressive boys at school are not those who are high in stress hormones, but low in them. Their anger simmers beneath the surface, probably outside their awareness. It also probably arose from very early experiences of neglect or chronic hostility, which has affected their stress response. One important study (McBurnett *et al.* 2000) found that the earlier that antisocial behaviour develops in boys, the more likely it is to be associated with low cortisol. This suggests that the little terrors who are already upsetting others at nursery and primary school may do so because they have already had to develop a survival strategy to cope with low grade emotional abuse or neglect. Although they may appear 'tough' or strong because they seem to be insensitive to others and quite lacking in anxiety, their feelings are more suppressed than absent.

Children who show signs of aggression early on are different physiologically from boys who started to become aggressive only as teenagers. These later rebels, who behave antisocially as teenagers but hadn't done so as young children, are more in touch with their vulnerable feelings and still capable of expressing anxiety. Their high cortisol levels suggest that their teenage bad behaviour is a response (perhaps temporary) to the stresses of adolescence, rather than an outcome of early adverse experience.

However, those whose systems have adapted to stress early in life with a low cortisol defence are vulnerable to

a host of disorders. In particular, there is a strong link between low cortisol and post-traumatic stress disorder (PTSD), which will be discussed in a later chapter. They may also be prone to psychosomatic conditions such as chronic fatigue, asthma, allergies, arthritis and seasonal affective disorder (Heim *et al.* 2000). Low cortisol has also been associated with a lack of positive good feeling. Although it is not an active state of feeling bad, like depression, it may produce a sort of flattened emotional life. This is very suggestive of a type of emotional life which has been named 'alexithymia' – a difficulty in putting emotions into words. Indeed, one researcher has found decreased cortisol levels in people with alexithymia (Henry *et al.* 1992; Henry 1993).

This way of being was first identified in connection with patients with classically 'psychosomatic' disease, such as asthma, arthritis, or ulcerative colitis (Nemiah and Sifneos 1970), but its use has been extended to a much wider range of disorders. The difficulty in putting feelings into words probably originates in early parent–baby communication. If a mother figure does not teach her baby to put bodily experiences into words, then he may not develop the capacity to organise his feelings and contain tension through his own conscious mental processes without constantly relying on others. Indeed, those working with psychosomatic patients have found that they tend to depend heavily on one or a few other people, and when one of these key regulatory relationships is withdrawn or lost, they are vulnerable to illness (Taylor *et al.* 1997). This will be explored in Part 2 of the book.

One caveat against a neat division of people into those with 'high' and 'low' baseline cortisol is that we should probably not think of them as fixed states. Rather, a high cortisol state suggests someone who is currently engaged in struggling with stress in an active way, whilst a low cortisol state suggests that the balance between 'arousal and anti-arousal psychological mechanisms' (Mason *et al.* 2001) has tipped towards defending against feeling overwhelmed by stress. This perspective may help to make sense of some of the contradictory findings in the research literature, for

example, the evidence that some sexually abused children have high cortisol levels whilst others have low levels. If Mason and his colleagues are right, this may have more to do with their way of adapting to the unique complexities of their current circumstances

The social nature of cortisol regulation

Clearly, the stress response is one key element of our emotional make-up. When we are regulating our emotional states, we are also regulating our hormone and neurotransmitter levels. However, the ability to do this effectively is strongly influenced by our parent figures and their own capacity to tolerate their baby's cries and demands and their way of responding. Psychotherapists might prefer to think in terms of the parents' 'unconscious defences' being transmitted to their children in the way that they navigate the stormy ocean of their baby's moods and needs.

A robust stress response is rather like a strong immune system; in fact, as Candace Pert has argued, they are interconnected. It provides 'host resistance' to the future stresses of childhood and adult life. But like the 'social brain', it too is shaped by the quality of contact between parents and babies. Good emotional 'immunity' comes out of the experience of feeling safely held, touched, seen and helped to recover from stress, whilst the stress response is undermined by separation, uncertainty, lack of contact and lack of regulation.

Above all, it seems to be vital to be able to switch off the production of cortisol at the right moment, without being flooded by it or having to suppress it. This seems to me to have clear parallels with the management of emotion in general: to be able to tolerate and accept whatever feelings come, knowing that when they start to become overwhelming there are ways of dealing with them – either through strategies of distraction, or of finding relief through other people. This is the secure strategy outlined by attachment research. But the insecure strategies are more problematic: the resistant pattern resembles the high cortisol situation of being overwhelmed by feelings, whilst the avoidant pattern

of denial resembles the switched off low cortisol state. Both cause us continued trouble in emotional life.

There is a remarkably strong weight of evidence that has now accumulated in this field. It suggests very strongly that the HPA stress response can be programmed to be hypo- or hyper-responsive through early social experience, and that cortisol can have permanent effects on the developing baby's central nervous system. The way in which this manifests itself in particular individuals depends on the age at which their difficulties began, how chronic or intermittent they have been, and how intense. Research in this area continues, which will hopefully be able to make more specific links with various human conditions. However, there is little doubt that the stress response is one of the key indicators of the way an individual has learnt to regulate emotion.