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Building a brain

Form emerges in successive interaction.

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The basic brain

It is a beautiful spring morning. My cat lounges on a stone bench in the sun after breakfast, stretching himself to his full extent with evident pleasure. This is an image of simply being alive, a moment when the experience of existing and the sensory pleasures of sun, air, full belly are enough. But if a large dog should come past, the cat would also defend his own 'being' and would shoot off the bench and hide, or, if cornered, would hiss and snarl with his fur up to frighten off the dog. Likewise, if pangs of hunger alert him to his need for more energy supplies, he would make sure to keep his 'being' going by pursuing a mouse or vole. He may not have self-consciousness or verbal communication, but he has a range of basic feelings and reactions which prompt his behaviour and ensure his survival.

This is where human beings start too. We share with other mammals a core brain which ensures survival. A newborn baby has a basic version of these systems in place: a functioning nervous system which enables him or her to breathe, a visual system which allows him to track the movements around him and to see faces close up, a core consciousness based in the brainstem which reacts to sensory experiences and assesses them in terms of survival. The baby

also has some basic reflexes such as the ability to root for a breast and to suck milk to nourish himself, sad or angry cries to attract mother's attention, and a defensive freezing behaviour when threatened. As Jaak Panksepp (1998) puts it, 'the emotional systems that have been identified in animals correspond nicely to what are deemed to be basic emotional systems in humans'. But what distinguishes humans from other newborn mammals is the human baby's responsiveness to human interaction. Human beings are the most social of animals and are already distinctive in this way at birth, imitating a parent's facial movements and orienting themselves to faces very early on.

The primitive brain that we are born with basically ensures that the organism 'works'. The 'oldest' structures in evolutionary terms, such as the brainstem and sensorimotor cortex, are the parts of the brain which are most metabolically active in the newborn. The new baby's priority is the internal regulation of body systems; adaptation to external conditions, which is largely managed by his emotional responses, soon follows. The active baby seeks out interaction with others, turns away from others when overwhelmed, freezes when he feels at risk; he already has the rudiments of emotion and self-regulation. Emotions are first and foremost our guides to action: they are about going towards things or going away from them.

Getting away from danger is probably the most essential response for survival, and it is not surprising that the fear and self-defence system based in the amygdala is one of the first parts of the emotional brain to mature. As Joseph LeDoux, the amygdala expert, describes it, when you see a twig on your path that looks like a snake, you jump back fearfully, or freeze – you act first, think later (LeDoux 1998). But although these sorts of reactions are hard-wired and automatic, LeDoux suggests that they are also open to learning and memory. We adapt to local conditions by noting and unconsciously remembering the particular experiences that generate fear in early life, using them as cues which tend to become an 'indelible', unconscious, primary repertoire of fear reactions. If you have bad experiences with a shrill-voiced babysitter in infancy, you may shrink from shrill-voiced people for the rest of your life without knowing why. These underlying emotional systems generate the overall state of the organism, and the basic meaning we attribute to situations. Approach or avoid, live or die.

But Jonathan Turner suggests that these basic emotions of anger and fear are far too negative to be the basis for a social way of life (Turner 2000). They may work for cats who interact largely to defend their individual territory, but they do not work for a species which bands together in social groups. Living a social life as humans do involves a degree of sensitivity and responsiveness to others, which other animals don't on the whole need. Human beings, on the other hand, need a lot more than fear and anger to live together co-operatively.

Turner suggests this is why fear and anger were elaborated into more complex states such as sadness, shame and guilt – all feelings which help us to control our behaviour to meet social goals. At the same time, the basic emotion of satisfaction was enlarged into the more intense feelings of love, pleasure and happiness which have the capacity to bind people together. As layer upon layer of these more complex emotions developed in human interaction, they also took shape physiologically in the structure of the brain itself. Since Paul MacLean suggested in 1970 that there was a 'triune' brain, or three-brains-in-one, there has been general recognition that the brain is structured by evolution, starting with a reptilian brain, on top of which developed a mammalian emotional brain, and finally a human neocortex. As Reg Morrison vividly described it, the human brain is 'like an old farmhouse, a crude patchwork of lean-tos and other extensions that conceal entirely the ancient amphibian-reptilian toolshed at its core' (Morrison 1999). The most basic functions of life are found in this 'toolshed' at the base of the brain, above which the emotional reaction systems develop. Beyond and around those systems lie the prefrontal cortex and cingulate, which have been thought of as the thinking part of the emotional brain, where emotional experience is held on line and alternative courses of action considered (see Figure 2.1).

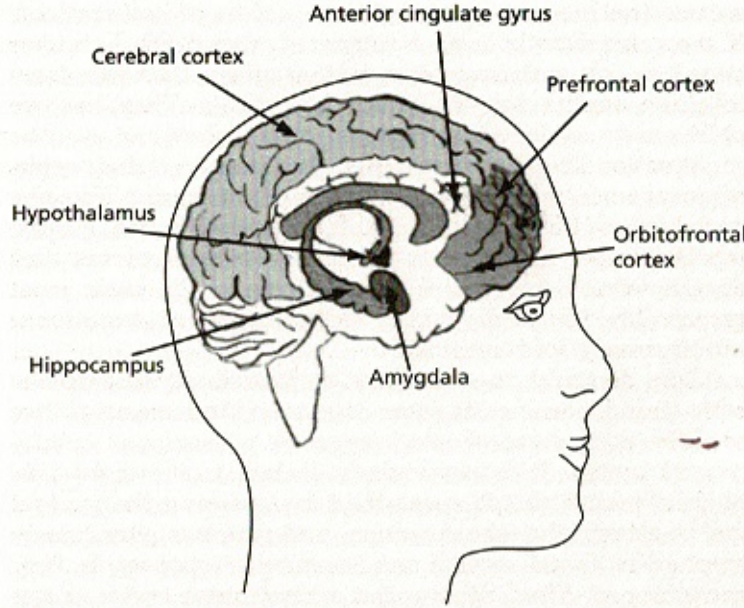

Figure 2.1 **The human brain.**

The social brain

Turner suggests our rationality and our language abilities grew out of 'our ability to be so emotional' (Turner 2000: 60). As the emotional brain developed, and we became more emotionally complex and sophisticated, more alternatives and choices arose in our interactions with others. This then required a capacity to think and reflect on our emotions, and thus led to the development of the cortex, and in particular, the prefrontal cortex. The prefrontal part of the cortex has a unique role. It links the sensory areas of the cortex with the emotional and survival-oriented subcortex.

The first part of this prefrontal, thoughtful response to emotions to mature is the orbitofrontal part (which is found behind the eyes, next to the amygdala and cingulate, see Figure 2.1.) The orbitofrontal cortex is a big part of our story as it plays a key role in emotional life. Through studying what happens when this part of the brain is damaged, neuroscientists have put together a picture of its functions. If the orbitofrontal area is impaired, social life is undermined. People with brain damage that affects the orbitofrontal area can't relate to others sensitively. They become oblivious to social and emotional cues – they can even be sociopathic. They may be prone to dissociation if their orbitofrontal cortex is not able to integrate information from the environment with inner states. So the orbitofrontal cortex, together with other parts of the prefrontal cortex and anterior cingulate, is probably the area of the brain most responsible for what Daniel Goleman called 'emotional intelligence' (Goleman 1996).

The capacity to empathise, to vicariously experience what they experience to some degree and to have an ability to infer their state of mind, requires a developed orbitofrontal cortex. It is particularly linked to the right side of the brain, which is specialised for grasping the general feel of things, the whole picture, and which is particularly involved in visual, spatial and emotional responses. In fact, according to Allan Schore, the orbitofrontal cortex is the controller for the entire right brain, which is dominant throughout infancy (Schore 2003). It is also larger on the right side of the brain. This may be where our emotional vocabulary and capacity to identify feelings are processed, including some of our aesthetic experiences involving the flavour of food, the pleasure of touch, and the recognition of beauty (Rolls 1999). It has the highest level of opioids in the cerebral cortex and is highly involved in rewarding, pleasurable experiences of various kinds. But at the same time, the orbitofrontal cortex is very involved with managing emotional behaviours and responding to other people and their emotional cues. This managerial role is achieved through its strong neural connections with the subcortical basic emotional systems. It is important in the control of emotional responses.

This is particularly necessary when faced with painful social experiences – such as the pain of separation from a loved one or the sick feeling of shame. Whilst intense social emotions are spontaneously generated by the deeper layers of the brain in the amygdala and hypothalamus, the prefrontal cortex acts as a kind of control centre from which these and other parts of the brain can be activated or inhibited. When someone feels strong rage or fear or sexual desire, it is the orbitofrontal cortex which notices whether a behaviour is currently socially acceptable, and has the capacity to suppress impulses (O'Doherty *et al.* 2003). It holds back what LeDoux calls the 'fast and dirty' emotional responses by activating more thoughtful, complex motivations. Through its connections to the more primitive brain systems, it can inhibit rage reactions, switch off fear, and generally apply brakes to feelings that arise in the subcortical areas.

This ability to hold back and defer immediate impulses and desires is the basis for our will power and self-control, as well as our capacity for empathy. But the orbitofrontal area really works as an accessory to the emotional impulses. It can only 'fine tune' the deeper areas of the brain whilst they are activated. It doesn't work on its own. In the past, this part of the brain may have been neglected due to what Don Tucker has called 'cortical chauvinism' (Tucker 1992), an overvaluing of the 'higher' cortex and a neglect of this area linking cortex and subcortex.

How the social brain develops

I was surprised to discover that we are not born with these capacities. There are parents who hit their baby in the vain hope that he will stop crying or will eat the soggy carrot mush they have been trying to get him to finish for the last half an hour. But it is no good trying to 'discipline' a baby or to expect a baby to control its behaviour, since the brain capacity to do so does not yet exist. A baby cannot thoughtfully consider his mother's frustration and decide to eat up to keep her happy. His social capacities are mostly potential, not actual at birth. What needs to be written in neon letters lit up against a night sky is that the orbitofrontal cortex, which is so much about being human, develops almost entirely post-natally. This part of the brain develops after birth and doesn't begin to mature until toddlerhood.

Nor is it just a matter of waiting patiently for your baby to develop an orbitofrontal cortex as a matter of course. There is nothing automatic about it. Instead, the kind of brain that each baby develops is the brain that comes out of his or her particular experiences with people. It is very 'experience dependent' as the researchers put it. This means it is built up through experience, probably for a good evolutionary reason: so that each new human can be moulded to the environmental niche in which he finds himself. Precisely because we are so dependent as babies, and our brains at this stage are so 'plastic' (that is, easily changed), we can learn to fit in with whatever culture and circumstances we find ourselves in. The way I have come to think of it is that in effect, when we are babies, our brains are socially programmed by the older members of our community, so that we adapt to the particular family and social group we must live among.

So the first 'higher' brain capacities to develop are social, and they develop in response to social experience. Rather than holding up flashcards to a baby, it would be more appropriate to the baby's stage of development to simply hold him and enjoy him. Without the appropriate one-to-one social experience with a caring adult, the baby's orbitofrontal cortex is unlikely to develop well. Timing may also be crucial. Although a precisely timed 'sensitive period' has not been identified in humans as yet, there is evidence to suggest that there is a critical window of opportunity in growing this social part of the brain. In one early experiment, the primate researcher Harry Harlow found that if he isolated monkeys for the first year of life, they became effectively autistic and lost the ability to relate to other monkeys (Blum 2003). More recently, work done with Romanian orphans has shown that those who were cut off from close bonds with an adult by being left in their cots all day, unable to make relationships, had a virtual black hole where their orbitofrontal cortex should be (Chugani *et al.* 2001). When social relationships are denied during the period in which this part of the brain normally develops (up to the age of 3), there is little hope of fully recovering these lost social abilities or of developing this part of the brain adequately.

A baby can't develop an orbitofrontal cortex on his or her own. It depends on the relationships with other people that are available. It is hard to imagine how a baby could make himself a social person if he lived in conditions of social isolation. The case of Genie, a little girl kept in one room by her parents for most of the first 13 years of her life, showed how difficult it was to recover from such a beginning. Genie was almost certainly neglected from birth. Her older sister had been left in the garage so that her parents did not have to hear her cry; she had died aged 2 months of cold and neglect. From the age of 20 months, Genie herself was kept alone in a back bedroom, tied to a potty chair. She could not move or see out of the window. When she vocalised her needs, her father came upstairs and beat her with a wooden stick. This incredible deprivation continued until she was 13. Her rescuers found her to be incontinent, slow to react, unable to talk, with the motor skills of a 2-year-old, obsessed with objects, and trained by fear to suppress all emotional self-expression. When she felt angry, she would attack herself, scratching at her face, blowing her nose and urinating. She craved affection but made no lasting relationships when last documented in her late twenties (Rymer 1994).

In a sense, the human baby has to be invited to participate in human culture. The first step in the process is to get the baby hooked on social interaction itself by making it highly pleasurable. In my work with mothers and babies, this has become a sort of benchmark – if a mother is finding pleasure in her relationship with her baby, then usually there is little to worry about, even if there are some problems. When the relationship is dominated by pleasurable interactions, the parent and the baby are, without realising it, building up the baby's prefrontal cortex and developing his capacities for self-regulation and complex social interactions. Most families do enjoy their babies in this way. But the mother-and-baby system is a delicate one, and can be easily derailed by a lack of inner or outer resources. Fortunately, it can often be put back on track with the right help at the right moment.

One mother I worked with, Sarah, was a highly successful professional who came to me in a very agitated and anxious state when she had her first baby. She was having great difficulty in breastfeeding. She had come to motherhood late and desperately wanted to get it right, but the tension between mother and baby was palpable. The baby had a flat, dull expression and turned away when her mother came near. Sarah resented her so much that she confessed she could not pass an upstairs window without having fantasies of throwing her baby out. Yet this situation was improved in a matter of weeks as the mother learnt to follow her baby's lead and let her baby tell her what she needed. Soon she started to relax, the baby started to relax, and before long the positive mutual feedback increased to the point where Sarah came in to see me with her baby, shining with love, and adoring her baby, whilst the baby smiled back at her. Pleasure had been restored.

The first sources of pleasure are smell, touch and sound. Babies can recognise their parents' voices from the start, and prefer them to any other. Being lovingly held is the greatest spur to development, more so even than breastfeeding. It is no accident that the image of Madonna and child has become an icon in human culture. In mother's or father's arms, where it is safe and warm, muscles can relax and breathing can deepen, as tensions are dispersed by gentle stroking or calm rocking. The baby's heart rate has been found to synchronise with the parent's heart rate; if she is relaxed and in a coherent state, so will the baby be. Her autonomic nervous system in effect communicates with her baby's nervous system, soothing it through touch. When we are physically held, we know that we are supported by others. There is a moment in Ashley Montague's film, *Touching*, which conveys this movingly: a distraught and distracted patient in a mental hospital, being interviewed by a psychiatrist, seems much more able to focus on the psychiatrist's face and engage with him when the psychiatrist reaches out and grasps his hand to convey his concern for the patient. These deep satisfactions of touch remain part of adult life, as bereaved people are comforted by a hug, partners communicate how 'in touch' they are with each other sexually, or people let go of the stresses of their daily life with a massage.

The power of a smile

As the world comes into focus, vision plays an increasingly important part in relationships. Eye contact now becomes the main source of information about other people's feelings and intentions: feelings are seen on the face. This reliance on faces may have evolved on the African savannah where it was necessary for our primate ancestors to communicate silently so as not to alert predators. This was done through visual means, developing a wide repertoire of facial movements and body language to convey information (Turner 2000). Certainly attentiveness to faces is hard-wired into human beings and is evident even in newborns.

By toddlerhood, the human child has started to use his mother's and father's faces as his immediate guides to behaviour in his particular environment. Is it safe to crawl out of this door? Does Dad like this visitor? This is known as 'social referencing', with the infant using visual communication at a distance to check out what to do and what not to do, what to feel and what not to feel, using the parent's facial expression as his source of information (Feinman 1992).

But according to Allan Schore, looking at faces has an even more powerful role to play in human life. Especially in infancy, these looks and smiles actually help the brain to grow. How does this work? Schore suggests that it is positive looks which are the most vital stimulus to the growth of the social, emotionally intelligent, brain (Figure 2.2).

When the baby looks at his mother (or father), he reads her dilated pupils as information that her sympathetic nervous system is aroused, and she is experiencing pleasurable arousal. In response, his own nervous system becomes pleasurably aroused and his own heart rate goes up. These processes trigger off a biochemical response. First, a pleasure neuropeptide called beta-endorphin is released into the circulation and specifically into the orbitofrontal region of the brain. 'Endogenous' or home-made opioids like beta-endorphin are known to help neurons to grow, by regulating glucose and insulin (Schore 1994). As natural opioids, they also make you feel good. At the same time, another neurotransmitter called dopamine is released from the

Figure 2.2 **Positive looks are the most vital stimulus to growth of the social brain.**

brainstem, and again makes its way to the prefrontal cortex. This too enhances the uptake of glucose there, helping new tissue to grow in the prefrontal brain. Dopamine probably also feels good, insofar as it produces an energising and stimulating effect; it is involved in the anticipation of reward. So by this technical and circuitous route, we discover that the family's doting looks are triggering off the pleasurable biochemicals that actually help the social brain to grow (Schore 1994).

The baby's brain is doing a lot of growing in the first year – it more than doubles in weight. The enormously increased glucose metabolism of the first two years of life, triggered by the baby's biochemical responses to his mother, facilitates the expression of genes. Like so much else about human development, genetic expression frequently depends on social input to become manifest. The hippocampus, temporal cortex, prefrontal and anterior cingulate are all immature at birth. But the success of their growth

and genetic development depends on the amount of good experiences the individual has. Lots of positive experiences early on produce brains with more neuronal connections – more richly networked brains. We have all our neurons at birth, and we don't need to grow any more, but what we do need is to connect them up and make them work for us. With more connections, there is better performance and more ability to use particular areas of the brain.

In particular, between 6 and 12 months, there is a massive burst of these synaptic connections in the prefrontal cortex. They achieve their highest density just when the developing pleasurable relationship between parents and baby is most intense, and attachment bonds are being consolidated. This growth spurt in the prefrontal cortex reaches a final high pitch in early toddlerhood, when the novelty of being able to move independently creates elation in the toddler and pride and joy in his parents. In effect, the baby has now become a social being, with the beginnings of a social brain. But it takes most of the first year to reach this point.

Towards the end of the first year, the preparatory phase of infancy comes to an end. In some ways, the human baby now reaches the level of development that other animals achieve inside the womb. But by doing it outside the womb, human brain building is more open to social influence. This extended human dependency outside the womb enables an intense social bond between caregiver and child to develop. This generates the biochemicals that facilitate a high level of neural connections and brain growth which will never be as rapid again. However, connections do carry on being made throughout life. One demonstration of this was seen in Einstein's pickled brain which was examined a few years ago by researchers in Canada. They compared Einstein's brain with other brains of men who died at a comparable age, and found that Einstein's brain was 15 per cent wider in the parietal area than the other brains. The parietal area is the part of the brain involved in maths reasoning and visual–spatial thinking. The message here is: the more you use it, the more it develops. On the other hand, if you don't use it, you lose it – the absence of activity tends to make neurons atrophy like wasted muscles.

The infant navigator

The first year of life is mostly building up these mental 'muscles'. Connections are made at a rapid rate providing a dense network of possibilities, the raw materials from which mind will emerge. Then, experience begins to 'commit cells to their ultimate fates' (Greenough and Black 1992) as they take up their position in the whole system and start to die off if not used. This is known as 'pruning'. The brain keeps what is useful and lets go of the surplus connections that are not going to be needed for this particular life. Out of the chaotic overproduction of connections within the brain, patterns start to emerge. The most frequent and repetitive experiences start to form well-trodden pathways, whilst those connections that lie unused begin to be pruned away. The brain takes shape.

It does this through unconsciously registering the patterns that form when a group of neurons are active simultaneously. (Individual neurons cannot make patterns.) Patterns are formed by the ensemble of neurons as they rise into activity, respond to each other and to environmental stimuli, and then fade away, creating a 'cocktail party' of chatter in the brain (Varela *et al.* 1996). It is during the time when a brain region becomes metabolically active that it contributes to the behavioural repertoire of the individual (Chugani *et al.* 2001), suggesting that our social intelligence is particularly sensitive to the experiences we have between 6 and 18 months. Once neurons are formed into patterns, they can be used to organise experience and make interactions with others more predictable. As Daniel Siegel put it, the brain is an 'anticipation machine' (Siegel 1999). It is designed to help us navigate our way, providing expectations of likely outcomes and holding knowledge of our environment.

In effect, the baby's brain slowly begins to categorise his or her experiences with other people, by noticing unconsciously what its common features are, what happens over and over again. If her father always bursts into the house every evening, bangs the door, quickly picks her up and kisses her on the nose, the baby will start to form an expectation that this is what daddies do. If her mother always wrinkles her nose in disgust and grumbles when changing her nappy, pulling it off roughly, the baby will form the expectation that nappy changing is an unpleasant experience and maybe eventually that her bodily functions are a source of displeasure to others. It is the repeated and typical experiences that structure her brain – generating basic emotional categories much like 'dog' or 'table', but in a highly sensory form. The inner image will be of a prototype episode: how the other person's face looked, how I feel in my body when they do that thing. If an experience is not likely to recur, it does not need to be remembered because it is not of much use as a predictor.

Unless they are highly traumatic, one-off experiences leave little trace. The exception to this rule is that very highly charged and arousing experiences will be registered in the amygdala which is responsible for instant reactions to situations of danger. Faces with expressions of fear and anger will be registered there and will provoke an automatic response. These situations may be emergencies and need a very fast reaction. However, when there is a chronic lack of positive social interaction with others, the capacity to override such primitive responses may not develop. Post-natally formed links between the prefrontal cortex and amygdala may be pruned because they are not well established. They are then too weak to inhibit the amygdala's fearful responses, or to correct earlier fear conditioning that is no longer appropriate, leaving the individual prone to anxieties and fears.

These pathways and internal images provide a practical guide to interaction. We draw on them when some feature of the current moment triggers them. They don't get put into words because they don't need to be put into words. They simply underpin our behaviour and our expectations of others without our realising it. In fact, it seems that mostly we prefer our expectations to be confirmed, even if they are unpleasant (Swann 1987).

However, humans have developed a way to revise those inner images if circumstances change. This is the option of conscious self-awareness, which is offered by the prefrontal cortex and anterior cingulate. The way that these parts of the brain achieve this is by extending emotion in time, allowing the individual to reflect on experience and consider alternatives before acting. For example, the inner image and feeling of disgust and rejection which is triggered off by nappy changing may persist in later situations which trigger the same constellation of neurons – perhaps being given an enema in hospital. Instead of reacting automatically to this trigger, the prefrontal cortex can effectively press a pause button and consider whether it is really so shameful and disgusting when it is a necessary procedure to protect one's health.

The prefrontal cortex is uniquely positioned in the brain to assess the overall state of the organism and what its needs are. It is well connected to the internal subcortical emotional systems as well as to sensory information about the outside world. It also has connections to all the motor and chemical responses of the brain. As Damasio (1994) put it, this means it can 'eavesdrop' on the activities of the whole organism. It can be aware of what state self and other are in, and take action to curb behaviours that are not socially advantageous. This is done through the prefrontal's connections with the subcortical areas – including the hypothalamus and amygdala – which enable it to put the brakes on arousal and to suppress spontaneous emotional behaviours like aggression. In our hypothetical situation, it can also suppress the disgust felt by the individual in hospital and enable him to cope better with his enema.

The power of the image

As I have described, the first part of this vital social equipment to develop is the orbitofrontal part of the prefrontal cortex. This starts to mature by the age of about 10 months, when the baby is turning into a toddler with an orbitofrontal cortex that is beginning to connect up, although it will not function fully until he or she is about 18 months old.

This development ushers in a crucial period during which the brain develops a capacity for storing images. The

orbitofrontal cortex has specialised neurons for recognising faces, whilst another part of the brain (the temporal lobe), which also starts to mature at the same time, processes the visual side of faces. At first, these are like 'flashbulb' images, but as situations with other people get repeated over and over again, they become lasting images invested with emotion, images of self with other, not grounded in time or place, but etched in memory. This is a significant moment in human emotional life, because it is really the sketchy beginning of an inner life – an inner library of images that can be referred to that will become increasingly complex and loaded with associations and thoughts as the child grows up. These emotionally loaded images are probably quite close to the psychoanalytic idea of an 'inner object' or internalised mother.

The inner images also become an important source of emotional self-regulation. In future situations with similar types of emotional arousal, they can be used as a guide to behaviour in the absence of the caregiver. But without effective internalised parental strategies for soothing and calming high arousal in the right brain, the individual is vulnerable to stress, which can more easily escalate into overwhelming distress. At the same time, this capacity to hold emotional images of people and their expressions in mind, and to return to these images, underpins the building up of a complex human world of meaning that goes beyond a purely transient response to the moment.

Negative faces

However, this intense engagement with faces has its down side. Negative looks and interactions are also remembered and stored. A negative look can also trigger a biochemical response, just as the positive face does. The mother's disapproving face can trigger off stress hormones like cortisol which stops the endorphins and dopamine neurons in their tracks – and also stops the pleasurable feelings they generate. These looks have a powerful impact on the growing child. They have enormous power in babyhood and toddlerhood because the child is so dependent on the parent for regulation of his states, whether physiological or psychological. Anything that threatens this regulation is very stressful because it puts survival at risk. It does not make much difference whether the lack of regulation is caused by being emotionally isolated from the caregiver or physically isolated by separation. What a small child needs is an adult who is emotionally available and tuned in enough to help regulate his states. The well-documented harmful effects of separation are, I suspect, mostly due to being emotionally cut off and unregulated. One study of nursery school children showed that it was not the mother's absence in itself that increased stress hormones such as cortisol, but the absence of an adult figure who was responsive and alert to their states moment by moment. If there was a member of staff in the nursery school who took on this responsibility, their cortisol levels did not rise. Without such a figure, the child became stressed (Dettling *et al.* 2000).

However, the toddler's brain actually needs a certain amount of cortisol to complete its development at this time (Schore 1994). Increased levels of cortisol facilitate the growth of norepinephrine connections from the medulla up to the prefrontal cortex. This delivery of norepinephrine helps the orbitofrontal cortex to mature further in toddlerhood, by increasing blood flow to the area and by forming its links (via the hypothalamus) with the parasympathetic nervous system. The parasympathetic nervous system is vital to the growing child, because this is the inhibitory system which enables the child to stop doing something and to learn what behaviour is unacceptable or dangerous. As the toddler explores his local domestic world, the parent now issues a prohibition like 'No! Don't do that!' every nine minutes on average (Schore 1994). For the toddler, this is sobering. The world is no longer his oyster. There are dangers round every corner, there are limits on his joyful exploration of the world. He discovers that the wonderful parents who spent 90 per cent of their time in positive interactions during babyhood, making every effort to tune in to his moods, now can be horribly unattuned. They convey this through their cold tone of voice and their negative looks. Like the horse whisperer's technique with horses, the

toddler's parents get him into line by giving him the cold shoulder. They actively withdraw their attunement and convey to him that he has to fit in with the group's norms or he will be socially isolated. For a highly social creature like the human toddler, even more so than the horse, this is punishment indeed.

These disapproving or rejecting looks produce a sudden lurch from sympathetic arousal to parasympathetic arousal, creating the effects we experience in shame – a sudden drop in blood pressure and shallow breathing. I recall this feeling so clearly when, at the age of about 7, I was summoned to the headmaster's office. I admired and loved my headmaster and arrived with positive anticipation. But his face looked grim as I walked in – and what on earth was my mother doing there in the middle of the school day? She had apparently gone to see him to pass on a trivial complaint I had made to her when she came to say goodnight to me in bed the previous night. I had not been selected for the school relay race and thought I should have been. I remember the shock and humiliation of being called to account for my whingeing. I felt the blood draining from me and became extremely faint and nauseous, as momentarily things went black. I am now aware that what may have been happening was that the links between my orbitofrontal cortex and my vagus nerve (via the hypothalamus) had been strongly triggered by my shame, and my sympathetic arousal took a sudden nosedive.

Shame is an important dimension of socialisation. But what matters equally is recovery from shame. It is important to have a 'dose' of cortisol, it seems, but an 'overdose' is extremely unhelpful, as I will discuss further in the next chapter. Just as the child produces cortisol in response to the parent's face, so too does the dispersion of cortisol depend on a changed expression on the parent's face. The young child can't do this for himself, so if parents don't restore attunement and regulation, he may remain stuck in a state of arousal. The benefits of cortisol in helping the orbitofrontal cortex to inhibit emotional arousal may then be lost.

The verbal self

The final stage of the early emotional development of the brain is the development of a verbal self. We have seen how the baby's means of communicating with others gradually becomes more and more complex: starting with touch, moving into visual dominance, and then in the second and third years of life, finally including verbal communication. Each new mode of communication is added to the previous one, yet none are lost. We become more complex by building upon and adding to the previous stage of development – not by excluding it.

Once the orbitofrontal cortex is established, with its growing ability to manage feelings, the right and left sides of the orbitofrontal cortex start to knit together, linking the expression and management of feelings. There is a shift from right brain dominance towards the development of the left brain. The left brain has different modes of operation and is specialised for sequential and verbal processing – one message at a time, unlike the right brain's intuitive grasp of many modalities and the whole picture. As this shift occurs, the brain becomes more stable and less open to change. It seems as if the left brain creates a higher order operation based on the achievements of the right brain. It monitors the organised self that has emerged from the right brain's activities, it asserts the self and it expresses that sense of self to other people.

New key areas of the brain begin to develop. First, the anterior cingulate, encircling the amygdala and hypothalamus (see Figure 2.1), which is involved in paying attention to feelings (Rothbart, *et al.* 2000). This brings greater awareness of inner states like pain and pleasure. It seems to be involved in tuning in to our feelings (and those of others) and in feeling emotionally aroused, but may also play a part in controlling distress through diverting our attention elsewhere.

Soon after this, an important new part of the prefrontal cortex – the dorsolateral prefrontal cortex – also starts to develop. This is where we play around with our thoughts and feelings, where we think about them. The dorsolateral cortex is the main site of what is known as 'working memory'. By extending the activation of neuronal patterns in time, it can hold on to memories and thoughts and compare them. This capacity to hold things in mind is a key aspect of our ability to plan, to evaluate experience and to make choices. It gives us more flexibility and the opportunity to correct thinking in line with current experience. (Those people with a damaged dorsolateral cortex have a problem adapting; they tend to be rigid in their behaviour and get stuck on old ideas.) The dorsolateral cortex's talents lie primarily in juggling information – not in directly managing the subcortical emotional systems in the way that the orbitofrontal cortex does. They have different tasks.

The second year is notable for the increased linguistic ability that now develops, based in the left brain. Both the dorsolateral cortex and the anterior cingulate, which it is linked to, are involved in speech production and verbal fluency. (According to Panksepp, if the anterior cingulate is damaged, the *urge* to talk, or motivation to communicate feelings such as distress, is lost.) As these parts of the brain develop, words now start to play as big a part as looks. Emotions can be communicated verbally as well as through touch and body language. This conscious attention to emotions opens up a wider range of possible responses. Instead of relying on the automatic habits and expectations generated by the templates of past experience, there is now some room for manoeuvre. Ways of doing things and ways of thinking can be examined. More subtle or complex solutions may be arrived at, often through discussion with other people. Parents can now teach social rules in a more explicit way: 'We don't snatch other people's things' or 'If you eat up your fishfingers, I will give you your favourite yoghurt'.

This is a major shift from the previous way of registering experience in 'anticipatory images' of recurrent situations with people. However, that earlier non-verbal form of images, based largely on feedback from other people's faces and body language, continues to inform our emotional responses. But now there is a new verbal form of feedback from others to be mastered. The quality of this feedback matters. If caregivers are well attuned to the child, they will be able to acknowledge the child's current emotional state and to symbolise it accurately in words. This allows the child to build up an emotional vocabulary that can identify feelings accurately and can differentiate between different states – to know that feeling sad is different from feeling tired, for example. But if caregivers don't talk about feelings, or if they represent them inaccurately, it will be much more difficult for the child to express feelings and to negotiate around feelings with others. And if feelings remain unsymbolised, then emotional arousal cannot be managed in a more conscious, verbal fashion – such as 'talking oneself out of it' in a low mood. Instead, states will be processed through the old non-verbal channels, and will not get updated by new feedback and reflection. This means that the child's sense of self will also remain rather undifferentiated.

The sense of self is strongly affected by another part of the brain, the hippocampus, which also develops in the third year. Whilst working memory holds on temporarily to current experience, the hippocampus is more selective and holds on to the more significant elements of current experience until they can be stored in long-term memory. They then become a resource for the prefrontal cortex which can recall these explicit memories at any time. The hippocampus is strongly linked to both the anterior cingulate and the dorsolateral prefrontal cortex. Like the latter, the hippocampus is a place where sensory paths converge, a place which synthesises information and situates it in time and place. This means that it is now possible to remember a sequence of personal events: first this happened, then that happened to me. There is a before, during and after. This enables the child to start to create a personal narrative and to have a past and a future – to have a narrative self, not just a self who lives in the moment. Parents can now talk to their child about the future: 'Cheer up, we're going to the park to see the ducks later this morning' – and they can refer to the past 'Remember when you took off all your clothes at Uncle Bob's wedding!'

Probably, the reason that we cannot remember our early infancy is because the dorsolateral prefrontal cortex and its links to the hippocampus have not fully developed at that

time. Perhaps this is because in early life individual events are not so important as the gradual emergence of pattern and form from the hubbub of ordinary daily life. The most highly emotional memories from infancy are stored instead in more primitive systems like the amygdala, or in other brain pathways, and either way are not accessible to consciousness. They are the background to our life. But as we grow up, we may need to remember more specific information to guide our decision making. The hippocampus has this task of remembering where and when particular, significant events happened – the context and the place – and can make them accessible to conscious recall.

This whole left-brain dominated formation of dorsolateral prefrontal cortex, anterior cingulate and hippocampus together play a major role in the development of a social self who has an autobiography and who communicates with others verbally to sustain this sense of self. Surprisingly, the development of this verbal, narrative self has itself been found to be crucial to emotional security in adults. An important researcher in the field of attachment theory, Mary Main has worked on attachment patterns and has devised a way of measuring attachment security in adults. What she found was rather unexpected. She discovered that when adults talked about their emotional lives and their important relationships in growing up, it didn't matter whether they had a 'happy childhood' or not. Their current emotional security depended much more on having an internally coherent and consistent narrative than on the actual story they had to tell. The people who were in trouble emotionally were those who either found it difficult to talk freely about their feelings, or those who talked too much in a rambling and incoherent way. For example, if an adult took the view that he had had a wonderful relationship with his mother, yet could recall no memories of good moments that he had enjoyed with her, his narrative would be regarded as internally inconsistent (Dismissing). On the other hand, if an adult could not convey a coherent narrative about her past without getting caught up in painful, tangled memories and feelings, she would equally be regarded as insecure (Preoccupied) (Main and Goldwyn 1985). It is not clear to me whether the story itself plays some crucial role in creating a secure sense of self, or whether it is a by-product of the attentive relationships and good feedback from others which have produced a secure sense of self. Certainly, when emotions are either blocked from awareness or are out of control, there will be less possibility to reflect on them using the left brain's resources.

Genie – the child reared in isolation – had a relatively undeveloped left frontal cortex. In an era before the recent scanning techniques were in use, researchers used psychological tests on Genie. These tests revealed that she was not using her left brain for language, nor could she complete any left brain tasks. Of course, she had not received any emotional feedback except the instruction to shut up. Yet her right brain was a remarkable non-verbal communicator according to those who spent time with her. She could grasp the 'gestalt' of a situation in an 'uncanny' way. She could draw what she could not say. Susan Curtiss, one of the researchers involved with Genie, recalled the way that she made her desires and feelings known to strangers without a word. Genie had an obsession with plastic objects and would notice and covet anything plastic that anyone had: 'One day, we were walking – I think we were in Hollywood. I would act like an idiot, sing operatically, to get her to release some of that tension she always had. We reached the corner of this very busy intersection, and the light turned red, and we stopped. Suddenly, I heard the sound – it's a sound you can't mistake – of a handbag being spilled. A woman in a car that had stopped at the intersection was emptying her handbag and she got out of the car and ran over and gave it to Genie and then ran back to the car. A plastic handbag. Genie hadn't said a word' (Rymer 1994: 95).

These right brain abilities may have been amplified in Genie's case, but they do persist in all of us alongside our left brain verbal capacities. What seems to be most important for optimum emotional health is that the left brain's operations should be well connected to the right brain's information. If these connections are weak or are blocked in some way, the left brain is quite capable of spinning a story that is not anchored in emotional reality.

Lacking information, the left brain simply guesses and fills in the gaps as best it can. This may be the tendency of the Dismissing man, outlined above. Somehow, the left brain has become dominant but has lost touch with the right brain. On the other hand, in the case of the Preoccupied woman, it seems as if the right brain has not adequately established its links with the left brain's reflective and narrative capacities. The success or failure of these connections may depend on what happens in the child's important relationships during the second and third years, and whether adult caregivers have facilitated the connections between hemispheres and levels of the brain, by responding and talking to their child in a way that enables his emotions to be integrated into higher functioning.

It seems to be the process of putting feelings into words that enables the left and right brains to become integrated. When words accurately describe feelings, they can then be blended into a coherent whole. Eugene Gendlin's therapeutic work around the concept of 'focusing' describes this process of how people can learn to listen to their bodily 'felt sense' and express it carefully in words, thus linking the right brain 'felt sense' and the left brain's verbal account. Gendlin suggests that this is very different from the flatness of simply expressing your 'position' and hearing the other person's 'position' on something at a rational level. He describes how words that 'flow out of a feeling' are the kind that make you say '*that's what it's all about!*' and produce a 'body shift' which always feels good (Gendlin 1978). These links may be important because they allow the maximum information to flow freely between the two hemispheres. The mind is no longer trapped in unregulated emotional arousal, but is able to use all its resources, particularly those of the left brain, to regulate feelings.