5 Neuroscience and child psychotherapy

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Introduction

There have been many developments in our understanding of children's psychological and emotional development in recent decades, but no field has altered more dramatically and presented more challenges that that of neuroscience. In this chapter I will outline some of the main developments, in an uncomplicated way, and consider just what impact this new research might have both on our understanding of children's psyches and on how we might actually work clinically with children and adolescents. Of course neuroscience is by no means new to psychoanalysis. Freud himself, with his neurological training, showed enormous prescience in predicting the kind of developments that would not actually occur for another century: 'we must recollect that all our provisional ideas in psychology, will presumably some day be based on an organic superstructure' (Freud 1914: 78).

Innovations such as the MRI scan have opened up to scientific examination vast areas of brain functioning heretofore hidden from view. In the past our knowledge was gleaned only by cruder means such as autopsies on dead brains: if the brains of a dead person with a particular disorder showed a particular organic feature then scientists assumed that the symptom was due to organic causes, with no idea that experiences might affect the brain. Although neuroscience might still be in its infancy, our understanding is becoming more sophisticated, and it is now possible to observe, through scans, brain activity corresponding to very specific emotional states such as excitement or fear.

I will try to keep to the least technical and most clinically pertinent features of the research, taking in some fascinating facts about the human brain and its evolutionary history, about how experience affects both the architecture of the brain and its hormonal system, about the impact of trauma and neglect on the brain, in passing touching on mirror neurons and on some questions about memory and how emotional learning and remembering takes root. The chapter will also pay some attention to differences between right and left brain functioning, and – without any of us needing to be neuroscientists – I hope to convey a sense of the role of a few of the key parts of the brain that seem central to emotional functioning. Thinking about such matters can prod us to consider carefully what we prioritise in the therapeutic process and also raises questions about whether we should be hopeful or pessimistic about the possibility of change and growth after the first few years of life.

The brain: some facts and evolutionary history

Our brains are highly complicated and able to make incredibly complex calculations about psychological matters via almost infinite links and complex structures, within fractions of seconds. The fundamental units of the brain are 'neurons', which are long entities with a central nucleus (containing genes), and long extensions called axons (Figure 5.1).

Neurons connect to each other via synapses, which enable the transmission of neurotransmitters, which can then fire neuronal activity further 'downstream'. The average neuron incredibly connects directly to 10,000 other neurons and the average brain has 100 billion neurons. Each neuron has one or more axons, which send messages to other neurons, and axons branch so that there are far more synapses than neurons. In fact Pinker (2002) refers to 100 trillion synapses in the human brain. Each neuron has a cell body and tens of thousands of tiny branches (dendrites) which do the receiving via electro-chemical messages. A piece of brain the size of a grain of sand contains 100,000 neurons, 2 million axons and a billion synapses (Siegel 1999).

Furthermore different parts of our complex brains have evolved at different stages in our evolutionary history and serve different functions. Although slightly simplified, MacLean's (1985) concept of the triune brain is a useful starting point. This theory states that human brains can be related to three main stages in our evolutionary history: the reptilian brain, the limbic system and the neocortex (Figure 5.2).

Many aspects of our brain functioning have changed little since the reptilian brain reached its most advanced stage some 250 million years ago in reptiles, although it first evolved in fish 500 million years ago. As well as controlling things like heart rate, breathing, temperature and balance, it contains structures such as the brain stem which controls ancient but vital survival instincts, the best known of course being 'fight, flight or freeze', physiological and psychological states we see all too often in traumatised children. Some 100 million years later, with mammals, the limbic system came into existence, maybe the region that psychotherapists particularly interact with as it is really the seat of our emotional life, and concerns how we make judgements, learn whether an experience is likely to be pleasurable or not, and how we form emotional memories. It also contains vital structures that I will return to later, such as the amygdala and the hippocampus. The 'new kid on the block' is the neocortex, a mere two or three

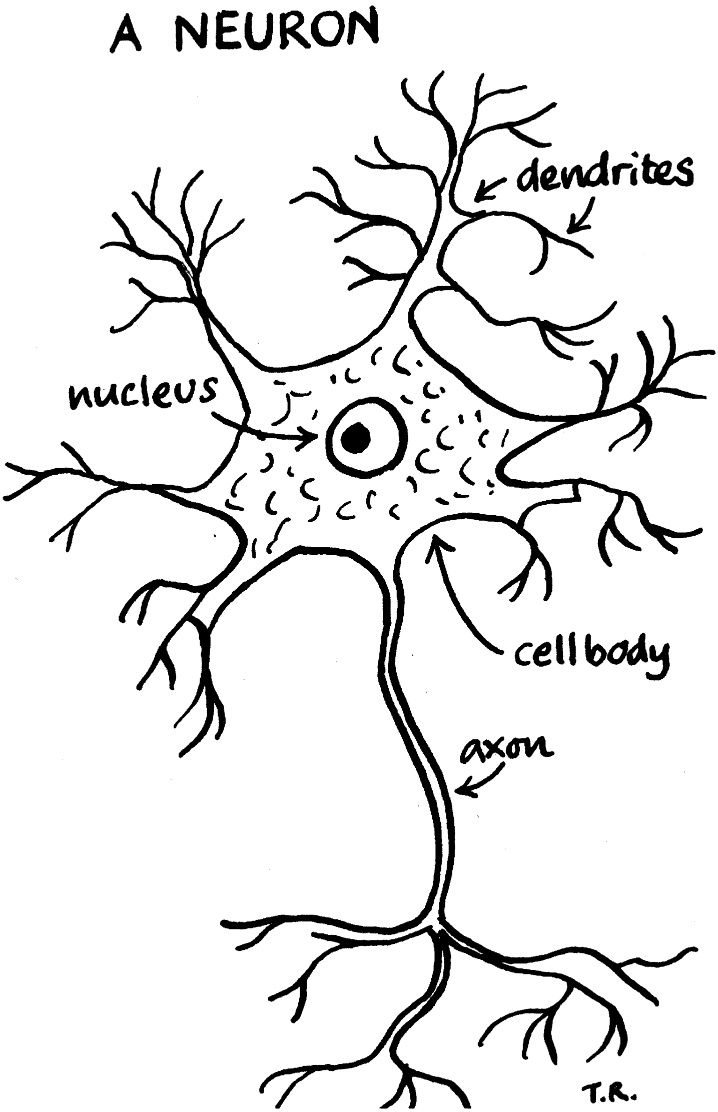

Figure 5.1

million years old, and its most complex form is seen in humans with our two cerebral hemispheres, responsible for human thought, language, imagination and consciousness.

It might be that the cerebral cortex undertakes, albeit loosely, many of the 'higher' functions that Freud believed resided in the ego, and which he saw as more highly evolved. An exercise I quite often undertake with myself when working with patients is to ask whether it is the reptilian or

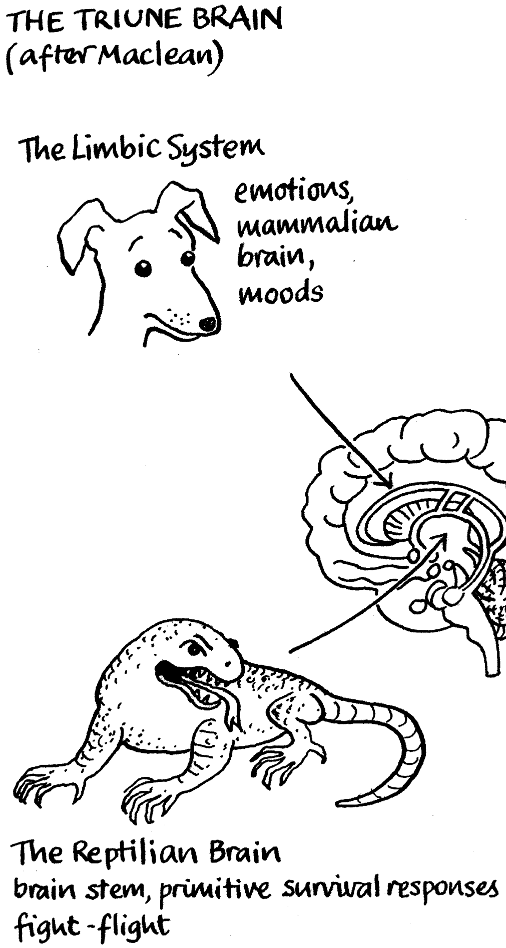

Figure 5.2

mammalian brains or the cerebral cortex that is active at a particular moment. Basic instinctual responses emanate from the reptilian brain, responses such as hate, lust, aggression, and particularly the powerful defensive strategies of fight, flight or freeze. If one is confronted by massive anger or hatred in a child who at that moment has a highly active brain stem and is in 'fight' mode, it is folly to make an intellectually complex comment that only the cerebral cortex could make sense of, as those more complex parts of the brain are not active at such moments. Similarly, how often might we engage with intellectually advanced but emotionally fragile adolescents in territory they feel all too comfortable with, intellectual ideas, whilst the terrifying emotional issues lurking below the surface are sidestepped? Of course more and more we work with children whose emotional lives have been unformed, or as Alvarez (1992) has written 'unmantled', and we then need to be working at very basic levels with the limbic system, to build basic emotional understanding in a developmental way (Hurry 1998). The three parts of the brain are not separate units by any means, and complex relationships and pathways have developed between them over the millennia. Indeed, the neuroscientist Daniel Siegel (1999) has argued firmly that psychological health is marked by ever-increasing complexity and interdependence of aspects of brain functioning, and that many of the people who have developed psychological 'issues' of one form or another show a less complex and interwoven structure, with more chaos and more rigidity, and less organisation. This emphasis on complexity and linking parts of the brain might echo Bion's theories about linking (1967) and about the value of 'capacious' containing functions.

Experience dependency

The brain is basically like a muscle group, albeit an extraordinarily complex one, and the bits that are used are strengthened from the exercise, and others can wither from neglect. The human brain is born prematurely, having an overabundance of brain cells at the start but with very few connections between them. In the post-natal period there is a massive process of 'pruning', a process called 'use it or lose it', and cells that are not used simply die off. Schwartz and Begley (2002: 117), quoting a figure of 20 billion synapses pruned every day between childhood and early adolescence, say: 'like bus routes with no customers, they go out of business'. Once a connection is formed it remains wired, but unused neurons are 'pruned', although new pathways and wiring can still form later in life. New experience is filtered through already-formed pathways, just as water will naturally flow down already formed channels, hence the phrase 'cells that fire together wire together', coined by the neuroscientist Hebb (1949), and called Hebb's law. This is what is meant by humans having an 'experience dependent' brain and describes the process whereby particular pathways form at the expense of other potential pathways and become standard ways by which one experiences the world. Possibly similar to Bion's (1967) concept of linking, it is literally the case that physical (synaptic) links are formed in the brain as psychological links are made. Where neuroscience adds to, or even challenges Bion, is that, once formed, links are fairly solidly made; what we work with in many children may not simply be an attack on linking but a lack of links, of synaptic connections capable of joining two thoughts together.

This revisits the nature–nurture debate, which appears to have been given a whole new slant by recent research findings. Despite constant press reports about specific genes being discovered for particular disorders, research shows that in whatever ways one's genetic potential might vary, that potential also needs certain experiences to be triggered. There are, for example, two versions (long and short) of the 5HTT serotonin transporter gene. Several studies (e.g. Caspi *et al.* 2003) show that if one has particularly adverse experiences, such as abuse or neglect, one is very likely to develop aggressive behaviour if one has the short version of the gene, but if one has the long version the same adverse experiences do not seem to lead to violent behaviour. The short version also predisposes people to anxiety and depression (Caspi *et al.* 2002). Having a particular form of another gene, the MAO-A, has similarly been shown to predispose people to violence, again if the carrier has certain kinds of adverse experiences (Meyer-Lindenberg *et al.* 2006). Equally, it is proposed that the gene DRD4, when accompanied by certain experiences, is likely to lead to various kinds of novelty-seeking behaviours, making it more likely that the carrier might indulge in substance abuse and even possibly develop disorganised attachment patterns (Gervai *et al.* 2007). In these examples experience turns on genetic potentials, and one cannot elevate the influence of one over the other.

The human brain learns fast, according to experience, and is an extraordinarily powerful predictor of the future. If the presence of adults triggers either fear or dissociative processes, as it does in many children who have suffered early and ongoing trauma, these same fear responses will in all likelihood also be triggered by other more benign adults, such as kindly teachers or adoptive parents. The human brain, and particularly the infant brain, is hugely malleable, a capacity that Schore (2003) and others have described as 'neuroplasticity'. The period from the last trimester of pregnancy through to the second year of life is very crucial, although thankfully some plasticity remains throughout the lifespan, particularly during adolescence. Schore states the parent is the psychobiological regulator of the developing infant brain, and the mother's face can be the environment that stimulates particular neuronal circuitry, especially in the first few years. We are beginning to move from a model encompassing the single brain into one in which one brain activates another, an idea reminiscent of Winnicott's (1972) view that not only can one not conceive of a baby without also taking into account its primary carer, but also that a baby's self-understanding develops through seeing itself reflected in its mother's eyes.

Hormones and opiates

Experience affects not just the structure of the brain but also the whole hormonal system. The human brain produces many hormones and opiates, and the best known are the stress hormone, cortisol, and oxytocin, sometimes called the 'love hormone'. The mother's stress level during pregnancy affects the unborn child (Field 2004), and cortisol in pregnant mothers crosses the placenta and can adversely affect the developing foetus. Stress impacts on us via the HPA (hypothalamus-pituitary-adrenal) axis, a system that humans share with many organisms from way back in evolutionary history. With activation of the HPA axis comes the release of adrenaline into the bloodstream, faster heart rate and higher blood pressure, and readying the body for 'fight or flight'. Cortisol is nowadays easily measured on saliva samples and it is clear that when children are fearful, or when left without their closest attachment figures, their cortisol levels tend to become higher and their blood pressure and heart rates increase. Children who have been subjected to high levels of trauma or suffered consistent anxiety, such as many in our clinical caseloads, can have ongoing elevated cortisol rates. Cortisol has a number of pernicious effects, leading Sue Gerhardt (2004) to dub it 'corrosive cortisol', particularly in light of how it can attack cells in the hippocampus, the part of the brain that is central to memory, so being implicated in memory loss. Occasionally extreme trauma can have the opposite effect and result in extremely low cortisol levels – often seen in post-traumatic stress disorder victims such as Holocaust survivors (Yehuda *et al.* 2000). Either way, too much or too little cortisol or stress is not what the human body was designed for. Of course, quick surges of adrenaline and cortisol are essential and lifesaving when a predator suddenly pops into view. Generally after such shocks the body goes quickly back to a more normal state, with blood pressure and heart rates reducing again as we relax. However, if one has been subjected to constant assaults or cumulative trauma (Khan 1963) it is possible to become either hyper-aroused, sensing danger everywhere and barely ever calming down, or the opposite, a suppressed, closed down self-protective state that one sees in massive dissociation. As therapists we need to learn to be extremely sensitive to the nuances of such different psychological states.

Good or loving experiences lead to very different chemicals being released. The best known of these is probably oxytocin, a hormone that promotes warm and affiliative feelings, and also its close relation, vasopressin. Primates that 'pair bond', such as humans, have more oxytocin receptors than species that do not. Oxytocin levels increase when we are with someone we love, when breast-feeding, in sexual relations, when receiving a massage, and oxytocin also reduces the impact of stress, lessens pain and can boost the immune system. If we have higher oxytocin levels, research shows that we are more generous (Kosfeld *et al.* 2005), and if experimentally given oxytocin we also become more trusting and helpful (Zak 2007). With higher oxytocin levels we have less social fear (Meyer-Lindenberg *et al.* 2005), less activation of the parts of the brain concerned with fear and stress. Interestingly, preliminary evidence (Pollak 2005) suggests that late adopted Romanian orphans do not release oxytocin when cuddled or sitting on their mothers' laps in the same way that birth children do. This might explain how the capacity for affection, and its neuronal concomitants, might well atrophy with profound neglect, and it also might well be part of the explanation for why it can also be hard to warm to some neglected children. Such findings suggest that the role of the psychoanalytic child psychotherapist might also include the fostering of positive or more hopeful feelings as well as managing negative ones, something that has maybe historically been somewhat neglected in some traditions.

There are of course myriad other opiates and hormones, including dopamine and serotonin. Dopamine is central to the reward system, activated when we are positive, excited or eager for something, but it is also involved in addiction, such as to drugs and alcohol. Serotonin is similarly well known, and low levels of serotonin are seen in people who are less happy, more irritable and volatile, and particularly in violent males. We produce serotonin naturally when we feel good, something interestingly that antidepressants such as Prozac also do. Depressed mothers have low dopamine levels, but more worryingly so do their babies as young as a month old. Many current medical and recreational drugs target specific brain areas, and indeed many mimic the body's own opiates. Cocaine, for example, impacts on the dopamine system, and experiments have shown that if you put cocaine in a room full of rats, it is mainly the low-status ones that imbibe it (Wilkinson 2005). As Wilkinson and others (e.g. Marmot 2004) have shown by examining data across many societies, low social status gives rise to higher stress levels, weaker immune systems, and far poorer health and mental health outcomes, and also often increased use of opiates that induce positive feeling. The hormonal system is a complex one, and as psychotherapists we might unwittingly often find ourselves resonating with its impact in our countertransference responses to patients.

Aggression, violence and the negative

Neuroscientific, genetic and biological research challenges naive views that, given sufficient dosages of loving care, all will be well or the equally worrying, blame-filled idea that anything less than perfectly harmonious synchrony is a sign of bad parenting. Conflict is engrained in human nature: Trivers (1974) was the first evolutionary psychologist to point out the natural conflicts of interest between parents and children. Mothers and infants share only 50 per cent of their genes, and so do not always have the same goals. Haig (1993) has illustrated that it is in the interest of the foetus, not the mother, to transfer as many nutrients as possible across the placental wall. The foetus manipulates the mother by sending hormones into the mother's bloodstream that might, for example, raise maternal blood pressure, possibly giving rise to symptoms ranging in seriousness from swollen calves to more dangerous conditions such as pre-eclampsia, all in the service of increasing *its own* supply of nutrients. The not-so-innocent foetus cleverly controls supply lines of nutrients by remodelling the mother's very arteries, leading some to liken it to a cosmonaut taking charge of a spacecraft. Such research might find echoes in many of Melanie Klein's (1957) descriptions of primitive aggressive phantasies and aggressive urges in the infant.

Such evolutionary conflict is not just between foetus and mother. The foetus itself is the locus of innumerable conflicts, perhaps the best documented being that between the male and female genome. Haig (1993) developed the idea of genetic imprinting, whereby the same gene will express itself differently depending on which parent it comes from. In an experiment done with mice, the male and female instructions in a specific gene were alternately 'knocked out', leaving only one gender's genome 'in charge' of the foetus. Those foetuses where the female genome ruled over the male became smaller and cleverer babies, seemingly as the mother would have it, whereas those born by rule of the male genome were huge and brawny, not at all in the interests of the mothers. Pregnancy would seem at a molecular level to be a kind of silent and hidden battle, with conflict engrained in our very genes and cell structure. Evolutionary psychologists have similarly suggested that the kinds of phantasies Klein (1957) described of infants wanting to kill unborn babies in their mothers' tummies might in fact have deadly serious survival functions in a barren hunter-gatherer environment which could only sustain at most the life of one infant every three or four years.

Aggression and its origins and how we work with it has long been a source of debate within psychoanalytic thinking. Many psychoanalysts (e.g. Klein 1957) have argued that aggression is primary, innate and basic to human nature, whereas others (e.g. Fairbairn 1952; Guntrip 1992) have believed that aggression is secondary, and likely to be a defensive response to other feelings such as shame or hurt. However, as Solms and Turnbull (2002) point out, there are in fact two very different aggression systems wired into us. One form is the aggression of the lion on the hunt stalking its prey – the *cold aggression* system, to do with need, not anger or rage, linked with 'moving towards' one's needs (aggression literally means moving towards). This kind of aggression simply dissipates when we are sated. Quite a different system leads to the *reactive aggression* of the hurt/angry person which derives from rage/shame/threat, and is linked to the amygdala and to fight/flight responses. This might well be the form of aggression we witness so often in many of our more deprived patients who easily see an attack where others would not, and whose aggression can be an extreme form of a much needed and developmentally helpful survival mechanism. We need to work differently with different forms of aggression and their concomitant brain states, and the apparently cold criminal adolescent requires a very different intervention from the hyper-reactive physically abused child or the spoilt narcissistic child.

Mirror neurons and Rizzolatti's monkeys

Psychotherapists have been increasingly aware of the need to adopt different therapeutic approaches with children who struggle to understand other minds, such as autistic children and those suffering massive early neglect.

The ability to empathise and understand other minds is more developed in children who are securely attached, or who have parents who are what Meins *et al.* (2002) have termed 'mind-minded', and have capacities that Fonagy and Allen (2006) describe by the term 'mentalisation'. We know that the human infant is primed from birth to be sensitive to and respond to other humans, particularly the mother. In the last ten years scientists have made a discovery that explains some of this, a discovery of which the neuroscientist Ramachandran (2000) wrote, 'I predict that mirror neurons will do for psychology what DNA did for biology.' The discovery was actually made by the Italian neuroscientists Rizzolatti and Gallese (Rizzolatti *et al.* 2001) who were experimenting with macaque monkeys, and found not only that a particular neuron will fire up when a monkey performs an action such as grasping, but that a monkey who was simply watching another monkey reach for a peanut also had a firing of that very same neuron. Indeed the 'eureka' moment occurred when one of the main scientists, Gallese, reached for a peanut himself and was shocked to note that the equipment similarly registered the same neuronal firing in the monkey at the moment that the monkey just *saw* him grasp his lunchtime snack.

There is a complex mirror neuron circuit in humans (Wolf *et al.* 2001). If I see you walk near a washing line as if you might walk into it, I might find myself ducking sympathetically – the corresponding neurons for that action are firing in my brain, too. Others have found close links between the neural mechanisms for imitation, language and empathy in humans (Iacoboni 2005). Such neurons fire at the sight of the grasping of an object, but not at the sight of the object, nor at a pantomime grasp, so the neurons respond to and simulate actual *intentions*, which is the way actions are learnt and then later replicated. Mirror neurons are similarly activated when we observe or imitate emotion, which in turn relates to how we learn to read and understand another's intentions, and thus to how we develop a sophisticated 'theory of other minds'.

Mirror neurons provide evidence of the human capacity to form powerful connections between people as they allow one person to understand from the inside what another person is doing or feeling. Interestingly, this activity seems to be dominant in the left hemisphere and mirror neurons are found in Broca's area in humans, a region central to language use, and it is believed that mirror neurons are involved in the expression of phonetic gestures and actions, possibly forming the basis of language development itself.

Current research suggests that deficits in the capacity for theory of mind and imitation in autism is linked to poorly functioning mirror neuron systems (Williams *et al.* 2001; Oberman *et al.* 2005), which would make sense of many of the struggles of our autistic patients. One wonders also about children such as those adopted from emotionally depriving care situations who seem to lack a developed capacity to be in touch with their own and other people's minds and emotions. Maybe their mirror neuron systems had no opportunity to develop, and certainly much of our work with these children can be trying to facilitate the development of such capacities. The neuronal circuit which houses mirror neurons confirms the central role of imitation in both learning and communication, and possibly also in developmental change in the therapeutic process too (Trevarthen *et al.* 1999).

Memories and emotional learning

Neuroscience and linked research has hugely increased our understanding of the different kinds of memories that we have, how we develop these and indeed the implications for clinical work. Much has changed since Freud's day and the belief that psychoanalytic cure necessitated the recovery of repressed memories. A simple starting point is to outline two different forms of memory. The first is often called declarative or explicit memory and is concerned with memories of facts and events that can be actually, consciously recalled and spoken about. Recalling a date or name would fall into this category, as would remembering a childhood event. The other kind of memory is procedural or implicit memory – although I am grossly simplifying here and these definitions can be more subtly defined (e.g. Solms and Turnbull 2002). Procedural memory is a kind of knowledge which describes non-conscious bodily-based memories such as 'how we do' things, and also describes the residues of certain traumas remembered at a somatic, non-conscious level. Procedural memories include skills such as riding a bike or playing an instrument, and also memories of how relationships are likely to go, based on previous experience. More often than not these are the kind of memories people take into new social contacts and relationships, and into the transference relationship in therapy, and are the result of prior learning. An abused child, for example, might have learnt to expect violence from adults and so might push away real caring gestures, based on an earlier, procedural memory of abusive adults.

Research has shown that by about six months of age children of depressed mothers act in a depressed way even with non-depressed, attuned adults (Pickens and Field 1993). The well-known 'still-face' experiments that Tronick (1989) and others undertook illustrate procedural expectations in young babies. When an interacting mother is suddenly asked to keep a still face, the babies become disturbed, self-soothe, try to seduce the mothers back and in many ways show that they already have expectations of relationships that are suddenly being challenged. Such preconceptions of relationships seem to become inscribed viscerally in our central nervous systems, and more primitive parts of our brains such as the basal ganglia are central in this. The child who expects violence may well be hyper-alert and jumpy, irrespective of who he is with; the brain circuits to do with violent reactivity might well be to the fore while those to do with self-regulation and processing emotional experience might be little used and not available. Similarly loving, attuned caregiving will in all likelihood give rise to a trusting view of other people, again all based on behavioural patterns and expectations laid down far outside consciousness.

Psychoanalytic psychotherapy has taken much of this on board already, with our emphasis on the 'here-and-now' transference relationship, the emphasis on working with the 'total situation' (Joseph 1985), and the idea that the therapist might be a new 'developmental object' (Hurry 1998) and so aid patients to learn new expectations of their objects, internal and external. We also work less with attempting to lift the veil of repression to reveal actual memories, and also less with cognitive based insights 'about' the patient, and more with procedural expectations about relationships as manifested in the transference. We struggle sometimes with the subtlety required to work with traumatic memories, which are often procedural and bodily based, and which it is not always helpful to talk about directly for a very long time. How one moves towards integrating such memories, often encapsulated and split off, into everyday understanding remains an ongoing debate.

Left and right hemispheres

No discussion of the brain would be complete without some mention of the left and right hemispheres, regions which, although linked and working together, tend to specialise in different functions. The left brain leads on language, instrumentality and logic while the right brain has particular strengths in intuitive and emotional processing, creativity and more 'holistic' skills. As a rule of thumb, the right brain receives signals from and controls the left side of the body, and the left brain links with the right side of the body. The left and right brain are linked by a part of the brain, really a bundle of nerves, called the 'corpus callosum'. When this was removed in some patients (Sperry *et al.* 1970) it was found that the two hemispheres seemed to work independently. For example, when a pencil was shown to such a patient's right hand and eye (controlled by their left hemisphere) the patient could name the pencil but could not describe what it was used for; similarly when shown to the left eye and hand, the patient knew what one did with the pencil but could not name it.

Schore (2003) stresses the importance of the early months and years of life, when huge developments are taking place in the right hemisphere, which can be viewed as the seat of emotional processing, along with other elements of the limbic system. The part of the brain which deals with logic and thinking, the left brain and parts of the cortex, which in evolutionary terms are relatively new, are in fact not much 'on-line' in the first couple of years when many vital neuronal pathways and synaptic connections are forming. Similarly the part of the brain that contextualises explicit or declarative memories, the hippocampus, is also not very developed in the first year or so of life. In other words, massive developments are taking place before the human mind is able consciously to remember actual events, and in particular many vital procedural memories and expectations are firmly entrenched well before very much conscious declarative functioning occurs. This might well suggest that much more of our work is or should be with these early developing psychological and emotional states, in which language and cognition play a lesser role (e.g. Lanyado 2004).

The other key difference between left and right brain functioning is that negative emotions tend to be processed more in the right brain, and positive ones in the left, so that, for example, when we watch an amusing film our brains are more likely to evidence left brain activity. Also, with more right brain activity our immune systems are less efficient, something that has been shown in experiments by exposing people to the flu virus, and noting that those with more right pre-frontal cortex activity were far more likely to succumb to the virus and had less anti-flu antibodies (Davidson *et al.* 2003). Stress has a bad effect on the immune system whilst happiness seems to enhance it. A fascinating retrospective study was done in Milwaukee of nuns (Danner *et al.* 2001) whose diaries, written on entering the order in the 1930s, were recently examined in detail, for example in terms of how many positive and negative words were used. Although the daily lives of all the nuns barely differed in terms of routine, diet, climate or how they spent their days, their relative longevity did differ vastly, and in direct proportion to how happy they had been over half a century before! Of the less positive ones, two-thirds had died before reaching 85 years, whereas 90 per cent of the happy ones were still going strong. These nuns would have had more left pre-frontal cortex activity and a boosted immune system. What the neuroscience research is showing is that there are very different systems in the brain for managing and processing negative as opposed to positive affect. Psychotherapy today needs to ensure that we are both working with managing the negative and helping patients to develop the capacity to sustain positive affect, ideas that have been around in child psychotherapy for quite some time (Freud, A. 1959; Alvarez 1992), if not always as common currency.

It may be that in much of our work with children, particularly the more disturbed, we are increasingly working with what might be loosely termed their right brains, including capacities for emotional regulation, or with procedural memories as manifested in the consulting room, or just in attuning to subtle emotional states. As a result there is probably less focus on ‘left brain’ more cognitive and interpretative work than in the past. However, as Siegel (1999) has argued clearly, it is the linking of left and right brain and the development of new pathways that is so vital, and we should not privilege one over the other. One central way of linking right and left brain functioning is via the development of narrative capacity, something we often see in children as they begin to play imaginatively and expressively in therapy. As Siegel has written, autobiographical memory appears to be dependent on parts of the cortex that undergo rapid growth and change in the first few years of life and are likely to mediate autobiographical consciousness. These capacities are apparent in both securely attached children and in their parents, as shown by analysis of Adult Attachment Interviews. Rich tales, stories and narratives about their lives become prominent in more secure children by the third year of life, but such narrative capacity seems to be under-developed in avoidant children or their often 'dismissive' (in attachment terms) parents. What seems vital for psychological health is that therapeutic work develops not just left and right brain functioning but the links between the two. Story-telling led by the left brain alone can be rather wild when not harnessed by right brain emotional understanding, as evidenced in the remarkable but oddly out-of-touch stories seen in studies of those with right hemisphere brain damage (Ramachandran 1999). We hope to develop not just a capacity to tell a story, but to develop a narrative that is emotionally true, that we trust, and it appears that this is something that requires both left and right brain functioning and good links between the two.

Trauma, neglect, the amygdala and the hippocampus

Child psychotherapists have always argued that the early years are vital. Just as the rat pup that is licked by its mother will cope better with stress as it gets older, so the parent's good emotional and physical contact with the infant is an innoculatory factor in growing up. With loving contact all manner of helpful and calming chemicals, opiates and hormones are released in both mother and infant, and distinctive synaptic connections and neuronal pathways take shape. When early experience is of trauma or neglect then quite different chemicals are released, and different neuronal pathways form. Blood pressure is higher, the stress hormones cortisol and adrenaline are released, heart rates increase, and high stress levels can become the infant's natural way of being. A small almond-shaped part of the brain called the amygdala is vital in such processes; it is the organ that responds to fear, and is very ancient in evolutionary terms, being present in pre-mammalian creatures (Figure 5.3).

From our primordial history we are primed to be alert to danger and to respond in micro-seconds to any threat, and the amygdala is the central organ involved in this. The kind of startle response we all might have to a loud noise might be an example of the amygdala in action. Infants and children subjected to trauma appear to have an amygdala on constant hyper-alert. Perry *et al.* (1995) have taught us a lot about the impact of trauma on brain development, and he has written of how such children can barely relax at all, are often constantly 'on the move', and can be prone to being given a diagnosis of attention-deficit hyperactivity disorder. The sympathetic nervous systems of such people are highly aroused.

There is an opposite response of the nervous system to stress and trauma, an activation of the parasympathetic nervous system. When this is

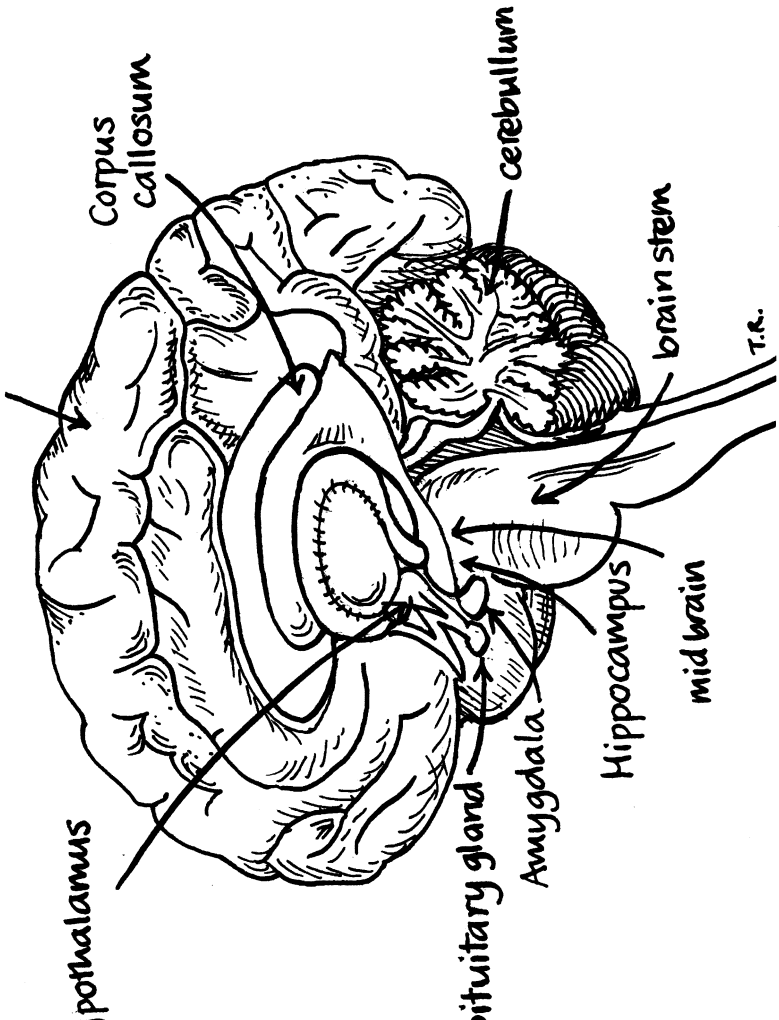
Corpus callosum
cerebullum
brain stem
T.R.
mid brain
Hippocampus
Amygdala
pituitary gland
hypothalamus

Figure 5.3

triggered the body closes down, rather like a creature playing dead in front of a predator. Blood pressure becomes low, as does the heart rate, and the mind goes into a kind of 'shut-down'. Such parasympathetic processes can then form the basis of the personality long after the original traumatic incidents are over. In fact the left side of the brain, the bit which specialises in logical thought, conscious memory and such, can often shut down when faced with trauma. At such times the survival mechanisms of the right brain take over. This is why many victims of trauma cannot consciously remember what happened to them. It is not that the memories were suppressed so much as that the part of the brain that would do the remembering had been shut down. This can also give rise to the phenomenon of dissociation, in which people can seem to be cut off from their own experiences, and might be another explanation for why many of the children from traumatising backgrounds often do not achieve well academically. They have learnt to cope either by being hyper-alert to danger, which impedes ordinary relaxed concentration, or they go into a shut-down, dissociative mode in which the thinking part of the brain becomes inactive. In trauma not only might the left brain shut down, but also the links between the left and right hemispheres are less strong. Indeed, trauma victims have been shown to have a smaller corpus callosum, that part of the brain that joins the left and right hemispheres, as well as having an enlarged amygdala, and there is also increasing evidence that the hippocampus can atrophy as a result of exposure to trauma, and that an excess of cortisol is directly implicated in this. There have been various reports of war veterans having diminished hippocampi (Greenfield 2002). As Siegel (1999) has stated, mental health might be characterised by increased complexity and interdependence of parts and right and left brains need each other, and a thick and active corpus callosum linking them is healthful, whereas an overactive amygdala or a corroded hippocampus or a diminished link between left and right brain is not. Maybe the role of much psychotherapy is in developing just these links, which is what happens for example in the consulting room when a patient realises with one's help that a noise outside, or a movement by the therapist, is not necessarily as dangerous or frightening as initially feared.

Severe neglect is different from trauma, but can lead to serious atrophy in certain parts of the brain, leading to massive developmental delay and serious deficits in the ability to empathise, to regulate emotions, and consequent deficits in the capacity to manage intimacy and ordinary social interaction. Studies of extreme cases of deprivation such as some terribly neglected children adopted from Romanian orphanages (e.g. Rutter *et al.* 1998), have shown the impact of such early deprivation not only on the behaviours of the children but on their actual brains as well. Indeed, their right hemispheres, brain areas which are primed for emotional understanding and expressiveness, seemed in the scans of the seriously neglected orphans to be almost like 'black holes', with shockingly little activity and life. Perry *et al.* (1995) have published research which shows that the actual circumference of the brain of severely abused children is often severely diminished compared to the norm, although brain growth and actual brain circumference will recover should they be adopted sufficiently early. Much research (e.g. Dozier 2001) seems to be converging to demonstrate that children who are fostered or adopted by sensitive carers very early, particularly in the first year to 18 months, have a far better prognosis than those adopted later. What also seems clear from work with such patients is that the level at which we work with them has had to change as a result of current knowledge. A lot of work with very deprived or neglected children needs to be in slowly building up emotional capacities (Hurry 1997), often in what Greenspan (1998) would call 'upregulating them' as well as in developing some capacities to understand other minds. With more traumatised children, much of what we are doing is 'downregulating' their sympathetic nervous systems, trying to break into their procedural expectations of the unsafeness of the world and to build more sense of trust and safety.

Hope or hopeless?

How hopeful or gloomy should such research leave us? We know that the behavioural patterns that are established early on can be very hard to shift, and that once an experience is burnt into the circuits of the amygdala it is there forever, but we also know that new circuits can also grow and form. Interestingly, this is also what story-stem research (Hodges *et al.* 2003) has shown, that after good adoptions the old stories and ways of being remain, but new expectations of parental behaviour and new views of the world can grow and become stronger. There are definite windows of opportunity during which certain aspects of brain growth can occur, and the brain can certainly change throughout the lifespan. It is also true that some opportunities can be lost forever if not taken in time. Language development is one well-known example, and it seems the same is also true for certain emotional capacities. The best-known windows of opportunity, when there is massive brain growth and change, are from pregnancy through the first few years of life, but also in adolescence when huge changes equally occur in the brain. Maybe it is not surprising that so much therapeutic effort and zeal is directed towards those age-groups.

Little research has been done on the effect of psychoanalytic psychotherapy, but some talking therapies have been shown to make a definite impact on the brains of patients (Mayberg 2006) and importantly it appears that such talking therapies affect a different part of the brain from drug treatments. Schwartz has written about how the mind, or a particular mental attitude, in fact changes brain states. From another angle Marci and colleagues (2007) found that patients whose treatment went best seemed to have attuned empathic therapists, and such empathy was measured via their skin conductivity as well as by other techniques. Treatment that went well showed high skin conduction concordance, much as more empathetic mothers show larger skin responses than those with lower empathy when watching five-month-olds.

Where the neuroscience research will take us in relation to psychotherapy is uncertain, but we do know that psychological and neurological change is genuinely possible throughout the lifespan. This can happen through good parenting, as is seen in studies of successful adoption (Hodges *et al.* 2003) or fostering (Dozier *et al.* 2001), and therapy, it seems, can also contribute to this, even if it is sometimes the result of slow and painstaking work. Therapeutic work might be helpful in a number of very different ways. The neuroscientist Joseph le Doux (1998) states that therapy is 'another way of creating synaptic potentiation in brain pathways that control the amygdala'. The amygdala's emotional memories are indelibly burned into its circuits, but we can regulate their expression. The way we do this is by getting the cortex to control the amygdala' as shown in Figure 5.4.

The amygdala is the seat of our primitive fear responses and reacts in a fraction of a second to any perceived danger. Experiences will often be filtered straight to the amygdala via the thalamus. However, there is a slightly longer route whereby experience is filtered via the more cognitive bit of the brain, and so the 'direct route' can be mediated by benign new experiences. A loud noise, for example, might cause an initial startle in a war veteran who then allows himself to become aware that the noise was simply a carpenter hammering next door, and he then relaxes. Therapeutic work can enhance such processes, building up the capacity to interpret experience in new and less frightening ways. This is but one way in which change can take place, and other effects of therapeutic work are likely to include the laying down of new procedural memories; strengthened links between left and right hemispheres; enhanced reflective capacities; better understanding of other minds; greater ability to form a coherent narrative about oneself; improved capacity to regulate emotions, to tolerate dependency and difficult emotions without acting out and to sustain positive affect; and the capability of course to form and manage attachments better in general.

Although there is a lot more to discover, neuroscience research has hugely increased our understanding of the ways in which children develop, as well as opening up all manner of challenges to the ways in which we have traditionally worked. 'Learning from experience' (Bion 1962), which inevitably also means changes in the brain, has been shown to take place throughout the lifespan, and child psychotherapy has a central part to play in ensuring this happens. It is increasingly clear that psychotherapy cannot ignore neuroscience; hopefully psychotherapy and neuroscience can develop in partnership in the coming years.

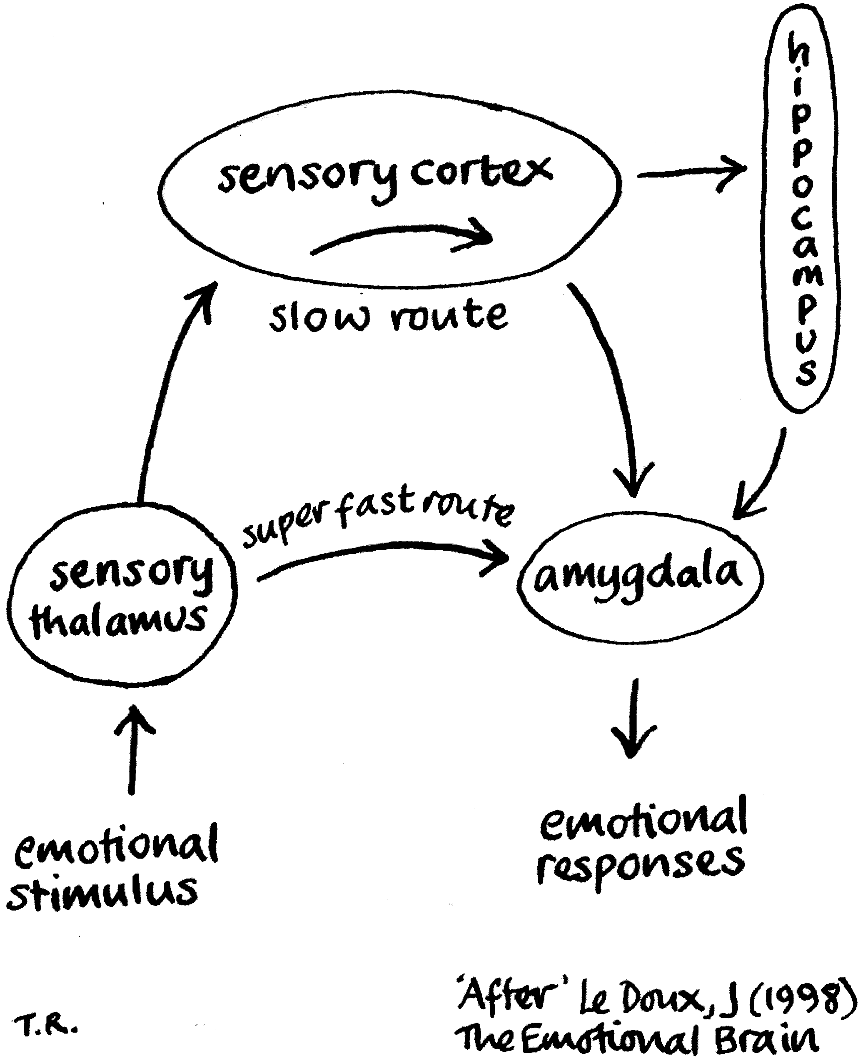

Figure 5.4

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