3.4

A Neurochemistry of Emotions and Behaviour

Thus far, I have suggested that human beings are emotionally driven, amoral and egoistic. I have examined how traits are genetically passed on from one generation to the next and how each human being is, nonetheless, influenced to some extent by the environment in which they live. I have also specifically explained that emotions are universal and, for the most part, negative. These considerations highlight the key fact that our core emotions are determined by our genetic make-up, rather than being learnt. This, however, does not mean that all of our emotions are instinctive. As has been mentioned above, some of our emotions, those which are probably not primordial, such as shame and embarrassment, appear to be intimately connected to our conscious selves and, as such, may be provoked by conscious thoughts as well as instincts.

A fundamental aspect of human nature which must, therefore, be highlighted is the fact that emotions, both our older and our more recent ones, are neurochemically mediated. One of the first to make this contention was Darwin, who speculated that emotions were initiated in the nervous system. In recent years, modern neuroscience has led to a better understanding of just how this occurs. Indeed, a great deal of recent research in neuroscience has been devoted to the study of emotions.[430] The results of these studies have effectively called into question the notion that the mind can be separated from the body, as René Descartes (1596–1650) famously conjectured when he argued that the nature of the mind and that of the body are so different from one another, that they must be able to exist independently.[431] In fact, we now know that psychology and physiology are inseparable as far as emotions are concerned.

This chapter outlines the way our emotions are caused by changes to the chemistry of our brains, illustrating this with a discussion of one of our oldest emotions – fear. It also considers how our neurochemistry may help to explain much of our behaviour, focussing, in particular, on the neurochemical processes underlying addiction, dissociative behaviour, libido, attraction and attachment, as well as what I refer to as the *neurochemistry of power*. Overall, this chapter illustrates what I mean when I say we are emotionally driven animals.

3.4.1. A Question of Chemistry

Joseph LeDoux, a leading neuroscientist who studies emotions, argues that understanding how emotions are neurochemically represented in the brain may help us gain a better understanding of them. This approach is quite different from psychological studies which examine emotions merely as psychological states.[432] A more accurate account, however, sees emotions as both physiological *and* psychological states.

Emotions are mostly located on the right side of the brain, particularly in the dorsolateral prefrontal cortex (DLPFC),[433] which plays a central role in the modulation of affective processing. Initial insights into the location of emotions inside the brain came from examinations of responses to external stimuli. Disturbing films triggered activity in the left visual field and transmitted it to the right side of the brain, while the same films projected onto the right visual field were transmitted to the left side of the brain and produced lower levels of negative feelings, thus pointing towards the existence of some form of emotional lateralisation in the brain.[434]

Research has shown that positive and negative emotions are underwritten by different structures in the brain, indicating, for instance, that the right hemisphere may have more control over emotions than the left. There is some debate, however, about whether negative and positive emotional processes can be precisely located within a geographical area of the brain's structure and whether 'hemisphere asymmetry' in the subjective experience of feelings and moods implies a different specialization for both hemispheres.[435]

Research using fMRI has further increased our knowledge of the neurophysiology of emotions by providing an advanced way of perceiving brain activity. As mentioned before, emotions are essential tools which equip us with the means to respond successfully to life's opportunities and challenges.[436] Fear, especially, was central to the survival of our ancestors. It is now known that fear is produced in the amygdala. The amygdala has connections to the autonomic nervous system, which controls physiological reflexes such as heart rate. It is also connected to other parts of the brain which process stimuli from the external environment. Winston describes the amygdala as a 'neurological crossroads, the hub of a network of pathways in the brain'. When some external event is perceived to present a possible danger, the amygdala triggers a fear response and a huge biochemical release, preparing the body with all of the neurological resources it may need in order to escape.[437]

Interestingly, consciousness is not involved in this fear response: 'So it turns out that our most primal emotion, to advance or retreat, is triggered so fast that it precedes all conscious thought and awareness.'[438] In Winston's words:

> [A]ll hell has broken loose. Biological sirens and alarms are wailing … your brain and your autonomic nervous system – the automatic controller of the gut, heart vessels and lungs – have gone into overdrive and produced a huge surge of adrenalin. This triggers a hormonal cascade inside you, an incredibly fast and powerful chemical relay-race designed to propel you away from a threatening situation. … The adrenalin makes your heart pound faster, increasing its normal resting rate by as much as two or three times. … You are also breathing much faster now, and the blood is being rapidly redistributed around your body. The blood vessels in unimportant areas like your stomach and your skin constrict, shunting blood away and into the now dilated vessels of the muscles of the limbs. Here the extra oxygen and fuel gained by your increased breathing can best be harnessed to flee from the threat, or even fight it. … As the adrenalin and cortisol continue to gush out into your blood, your pupils dilate, allowing you to see better in darkness and shadows and to perceive any movement around you more keenly. A kind of pain-dampening effect is switched on so that you won't be distracted from getting away by any injuries. Emergency reserves of glucose are released inside you to allow for especially intense bursts of muscular activity. Even your immune system is mobilizing to cope with the possibility of dealing with a serious wound.[439]

All humans are equipped with this emergency kick-start system, but people may not experience the same level of fear in response to the same sensory input. Indeed, the way people experience and respond to emotions is also a question of chemistry. For instance, some may be petrified by the idea of diving from a bridge into water below, while others may simply experience a degree of nervous tension. These differences are the result of variations in neurochemistry, especially in levels of neuropeptides and neurotransmitters such as serotonin and dopamine, which enable the transmission of fear-codifying impulses which connect the synapses between nerve endings.

Different networks of brain regions function together to produce different emotions in response to external stimuli or thoughts. Neurotransmitters and neuropeptides are responsible for connecting these different networks and, thereby, for allowing emotions to be generated. Variations in emotional traits are, thus, the result of how neurotransmitters and neuropeptides function. For example, it is thought that the neurotransmitter and hormone dopamine is particularly active in extroverted individuals, dopamine being responsible for producing feelings of desire, excitement and pleasure. Serotonin, another important neurotransmitter and hormone, is responsible instead for, *inter alia*, regulating mood, cognition, reward, as well as sexual desire and social behaviour.

Understanding how neurotransmitters link the environment to our emotions is key to comprehending what makes up our personalities. It is likely to explain why some personality traits are extremely difficult to alter, try as we might. For instance, if we have high dopamine reactivity, we may respond very positively to environmental rewards for effort, whereas people with low dopamine reactivity may not.[440] Similarly, since serotonin is closely linked to mood and social behaviour, higher or lower levels of that neurotransmitter may significantly impact both how we are feeling and how we behave towards others. On the one hand, since there is some evidence that low levels of serotonin may be one of the causes of clinical depression, it is often artificially supplied to people suffering from depression and anxiety disorders in the form of pharmaceutical antidepressants.[441] On the other, neuroscientific studies have also tried to demonstrate that serotonin hypofunction may be responsible for forms of impulsive aggression and anger.[442] The evidence on the matter is, at least to some degree, contradictory.[443] Understanding whether there is, indeed, such a link between serotonin and behaviour towards others may enable us, in the future, to alter these personality traits and behaviours. Variations in our neurochemical make-up are genetic in origin. Genetic heritage, therefore, plays a role in determining temperament by way of neurochemical differences in how the amygdala functions and its neural connections.

A large body of research on traits focusses on three qualities: fearfulness, boldness and aggressiveness. People who are uninhibited, calm and bold are, it is thought, likely to deal with life's unexpected occurrences fairly well because their responses to events are not likely to be exaggerated and will last no longer than necessary. Those who react to the unexpected or unfamiliar with excessive anxiety or aggression are, by contrast, likely to cope less well with life's highs and lows. This is because their stress response is relatively strong and lasts for longer than is necessary. Those who are anxious, inhibited and reactive are likely to be less resilient when faced with challenges and those who are aggressive, impulsive and irritable may be more prone to lash out and to project their emotions on others. Most personality types are a mixture of these ideal types, that is, midway temperaments, because this best ensures survival.[444]

Research into how neurochemical transmitters translate stimuli from our environment, as well as images and thoughts, is in its infancy, however. One complicating factor is the fact that several neurotransmitters, rather than just one, may be responsible for producing a particular emotion, making it harder to decipher the level of intensity among neurotransmitters.[445] Another complicating factor is that emotions most often do not have purely positive or purely negative aspects, but rather a combination of both.[446]

None of this, however, means that the environment cannot influence innate traits. Research is being carried out into how experiences can alter someone's inherited neurochemistry and, therefore, temperament. For example, it is possible that parenting may be able to alter the physiology of a child and, consequently, play a part in defining their temperament.[447]

3.4.2. Addiction

Neuroscientific research has increased our knowledge of the role of neurotransmitters in addictive processes and, as a result, of the physical origin of addiction. This has provided critical insight into the workings of our neuronal networks and, thus, into our motivations, nature and behaviour. Addiction is an extreme form of behaviour which uses existing neuronal networks. Studying it through various modalities, which include behavioural and neurochemistry studies, as well as brain imaging, may be the best way to understand what motivates human behaviour, albeit in an extreme way. It may provide a 'window on the mind', given that it gives us unique insight into how our neurochemistry can drive us in a very powerful way, even against our better judgement.

Indeed, the principal organ affected by addiction is the brain. Addictive drugs essentially use/misuse the brain's pre-programming to induce feelings of pleasure. Part of this pre-programming is concerned with what is called 'salience', which refers to matters having special relevance to one's survival. Issues which appear to be 'highly salient' or relevant' include threats, food and sex. The danger of addictive drugs is that they 'use' these ready-made structures, resulting in the activation of reward circuitries, which produces an extreme sense of pleasure. Consequently, abstaining from these drugs will produce feelings of uncontrollable craving as well as the other usual physiological features of withdrawal. When the brain's pleasure centres are stimulated, they send out signals to repeat the activity which is causing the feelings of pleasure. Not everyone, however, forms an addiction. This is because there are also areas of the brain which allow us to evaluate the consequences of such behaviour, such as the medial prefrontal cortex, the medial orbitofrontal cortex and the dorsal striatum, all of which are involved in computing the causal effectiveness of our own behaviour.[448] Most people would decide that, as pleasurable as it may be, drinking, eating or gambling excessively are unlikely to be a good thing in the longer run. Recent research has shown that the chance of relapse among rehabilitating methamphetamine addicts appears to be higher among those patients who are less adept at employing the analytical part of their brains.[449]

There is also evidence of a genetic predisposition to addiction. People who are genetically predisposed to impulsive behaviour, immediate gratification and risk taking are more prone to addiction.[450]

Drugs produce effects by travelling through the bloodstream to the brain, where they alter the function of particular brain cells. Cocaine, for example, stimulates the nuclei of certain brain cells, prompting a large release of particular neurotransmitters, which carry messages from one neuron or nerve cell in the brain to the next. Alcohol, by contrast, reduces their activity. Some drugs, such as amphetamine or cocaine, have an effect by preventing the uptake of neurotransmitters. Others, such as marijuana or heroin, copy specific neurotransmitters and can, thus, attach to receptors and activating neurons.

Resistance builds up because specific neurotransmitters are repeatedly over-stimulated and the body responds by reducing their sensitivity. Essentially, the neurons are overloaded by abnormally high levels of neurotransmitters like dopamine – the neurotransmitter largely responsible for feelings of pleasure – thus reducing the number of sites or receptors to which the neurotransmitters can attach. In order to achieve the same effect, the addict has to increase the dose of the substance to which he or she is addicted. The person will also get physical withdrawal symptoms when he or she stops taking the substance. These are provoked by a shock to the brain caused by the changed neurochemical environment.[451]

Much research on the neurobiological basis of addiction focusses on the way drugs affect the brain's reward system and stimulate dopamine-producing neurons, thereby generating feelings of euphoria and pleasure.[452] Researchers have found, for example, that a rush of dopamine in addicts' brains is what causes a cocaine high. In other words, what the cocaine addict craves is the surge of dopamine which produces sensations of euphoria.[453]

Specifically, researchers have been exploring the role of a family of dopamine receptors which appear to multiply in conjunction with cocaine, methamphetamine or nicotine. What this does is to enable a greater amount of the drug to enter neurons and stimulate those which produce dopamine.

To a certain extent, we are all addicts, in the sense that our brains are pre-programmed to want to 'feel good'. Therefore, we continuously seek to repeat any behaviour which produces a sense of well-being/ neurochemical gratification. This is what I term the *sustainable neurochemical gratification principle*. The feeling of gratification may occur as the result of instinctive 'salient' acts or it may be triggered by what we normatively decide is pleasurable (i.e. through established social or moral norms). As mentioned before, there are five main drivers of human action through which this neurochemical satisfaction is sought: power, profit, pleasure, pride and permanency. What this means for individuals, society at large and the global human system is that constructive/useful behaviour (e.g. excellence, lawfulness, moral conduct) ought to be normatively associated with feelings of reward and general self-interest. This will stimulate the repetition of that behaviour, and thus positively reinforce it, in order to produce feelings of gratification and pleasure in our brains. This implies that it is far more effective to reward good behaviour or rehabilitate bad behaviour than solely to punish bad behaviour.

3.4.3. Dissociative Behaviour

As the previous section illustrated, the brain's reward system plays a crucial role in motivating human behaviour. When impaired, however, it may give rise to what is known as *dissociative* behaviour.[454] This term refers to mental disorders which involve a disconnect or discontinuity between perceptions of the external world, of the self and of one's own thoughts and memories. Forms of dissociation are an involuntary way of escaping life and are usually developed as a reaction to trauma.[455] Indeed, it appears that some children who have suffered perpetual abuse tend to withdraw emotionally, as a way of attempting to heal. Unfortunately, as of yet, little is known about the neuronal systems used in dissociative behaviour. Nevertheless, Daniel Levine holds that some of the same regions of the brain are stimulated during dissociation as during 'fight or flight' behaviour, although they initiate different neurochemical combinations. As in fight or flight behaviour, levels of the hormone cortisol are high and those of oxytocin are low.

3.4.4. Libido, Attraction and Attachment

In his novella *Elective Affinities* (1809), Johann Wolfgang von Goethe (1749–1832) depicts couples in strong marriages as being like particles of quicksilver (as mercury was commonly known) which bind themselves to one another through a chemical process. This hints at the notion that love is all about chemistry. Research suggests that intimate relationships are, indeed, a question of 'good chemistry'. There are thought to be three neuronal systems linked to sex, reproduction and parenting. Libido is related to a desire for sexual gratification and is connected to oestrogens and androgens. Attraction refers to increased focus on a preferred sexual partner and is associated with the neurotransmitters *dopamine* and *norepinephrine* and lower levels of serotonin. The neuronal system implicated in male-female attachment, typically characterised by a sense of serenity, comfort, security and emotional connection, has been linked to two specific neuropeptides: oxytocin and vasopressin.[456]

In relation to attachment, the peptide *oxytocin* is released during key, intense emotional moments, such as birth, breast-feeding and sexual climax, and appears to be especially important in relation to female attachment towards both offspring and sexual partners.[457]

Oxytocin attaches to receptor molecules in regions of the brain which are associated with reward. It appears to be implicated in bonding through reward in relation to sexual and social relations. On the other hand, vasopressin is active in the bonding process and is responsible for orienting attention on relevant stimuli – in the case of male-female partnerships, towards the member of the opposite sex with whom the person is forming a close relationship.[458]

While the peptide is present in men, its effect is thought to be enhanced by oestrogen and dampened by testosterone, rendering it more potent in women than in men. This has led to speculation that human beings may have evolved the capacity for attachment as a means of preparing us for caring for children, who remain dependent for a comparatively long period of time.[459]

The neuronal circuits which are associated with libido, attraction and attachment have evolved to regulate different aspects of the reproductive cycle and they are connected to different types of behaviour. Libido ensures that individuals will seek sexual relations with other members of the same species and, if they are heterosexuals, thereby reproduce. Attraction ensures that individuals will seek genetically appropriate members of the species as potential mates. Attachment ensures that unions are maintained long enough to rear offspring, a period of time specific to each species.[460]

The neuronal circuits related to these emotions are thought to be discrete. In other words, a person can be attached to someone with whom they have never had sex or with whom they have ceased to have sexual relations. Alternatively, a person may be sexually attracted to and have sex with someone they do not love, and most likely would not love if they got to know them better.[461]

3.4.5. The Neurochemistry of Power

Before moving on to the next section of this book, however, it is also worth providing a brief overview of what I have referred to in other writings as the *neurochemistry of power*.[462] As I discussed in Chapter 3.1.1, power is one of the Neuro P5, the most important drivers of human behaviour. The feeling of power is fundamentally linked to the reward circuitry in our brains. This sensation is neurochemically represented by a release of dopamine into our systems, which triggers a feeling of pleasure. Dopamine activates the reward system, which is essential for the survival of our species, since it motivates us to re-engage in necessary behaviours, such as food consumption, in accordance with the 'sustainable neurochemical gratification principle'.[463] As I explained in the chapter on addiction, since dopamine is addictive and produces a 'high', human beings have the instinctive motivation to repeat actions and behaviours which are responsible for dopamine releases, be they healthy or unhealthy, such as the consumption of drugs, regardless of their social acceptability.[464] Power, therefore, has the same effect on our neurochemistry and, consequently, on our behaviour, as any other addictive substance.[465]

For this reason, power, especially absolute and unchecked power, is intoxicating and highly addictive.[466] It affects our cells and our neurochemistry – and, consequently, and even more notably, our behaviour – in a variety of ways. On the one hand, dopamine can produce heightened cognitive functions. On the other, it can trigger poor judgement,[467] a lack of inhibition, extreme narcissism, perverted behaviour and gruesome cruelty. It can make us impulsive, less risk-averse and less empathetic.[468] As I have previously discussed elsewhere, recent studies have also shown that high levels of dopamine are associated with a sense of personal destiny, risk-taking, preoccupation with the cosmic or religion, emotional detachment which can lead to ruthlessness, and an obsession with achieving goals and conquests.[469] Absolute power and the high it produces can also lead people to believe that a spiritual force is guiding their actions.[470] This has been the case not only with famous dictators, like Stalin, Hitler and Napoleon, but also with leaders of established democracies. For example, both former US President George Bush and former British Prime Minister Tony Blair seemed to believe that it was God's will that they wage war against Iraq. This irrational degree of certainty is a symptom of extremely high levels of dopamine. Further, the dopamine levels present in powerful individuals are also responsible for their strong egocentrism, as well as the paranoia which often plagues the powerful.[471] Indeed, as I briefly mentioned in Chapter 3.3, it is the constant fear of this loss of power, be it real or imagined, which will drive leaders to do anything at all to enhance their power and ensure it remains undisputed. Therefore, it is this pre-emptive response to fear which pushes them to go as far as committing acts of unspeakable cruelty both against those whom they perceive to be the enemy and sometimes even against their own.[472]

3.4.6. Fear-Induced Pre-emptive Aggression

As mentioned in the previous section, pre-emptive responses to fear often lie at the root of the commission by individuals of violent actions, and, in extreme cases, even conflicts and wars, and thus merit closer attention.

The seminal thinking of Hobbes provides a helpful starting point when examining the personal and political implications of fear. In particular, his insights on human behaviour under conditions of anarchy are instructive.[473] According to Hobbes, distrust pushes human beings to strike first in an attempt to protect themselves. This is particularly true when one doubts one's own abilities to mount a defence. In other words, Hobbes considered an offensive approach to be the logical answer to the combined effect of distrust in one's fellows coupled with a lack of faith in one's own defensive capacities. Moreover, Hobbes' theory postulates that a state of war persists at all times in cases in which an established superior power is absent (irrespective of whether there is ongoing physical conflict or violence). In addition, his theory assumes that no one has the necessary defensive capacities individually.[474]

Neuroscience has shed new light on Hobbes's observations that fear triggers highly offensive responses. From a neurobiological perspective, fear is a very complex emotion and its manifestations take several forms, depending on the nature of the threat. These will range from the full activation of what is known as the 'panic system' to various forms of anxiety which lead to adaptive behaviour which ensures our survival.[475] While the instinct to survive and the desire to avoid physical pain constitute powerful motivators to 'strike first', as Hobbes observed, there are other powerful stimuli creating fear responses. These include those I have grouped together as the Neuro P5. To summarise, it is not only aggression in the form of a 'strike' which is prompted by fear. Fear entails a whole range of reactions to satisfy the need for safety, such as the accumulation of profit.[476] As I explore in more depth in Chapter 4.4.8, although fear-induced pre-emptive aggression is the root cause of many conflicts and has contributed to major crises in history, dignity-based governance can help mitigate it in favour of more peaceful and prosperous outcomes for all.

* * *

To conclude, emotions are key physiological as well as psychological phenomena. They are central in counselling us as to how we ought to respond to external stimuli, be they natural or social, and play a fundamental role in conditioning our behaviour and our everyday actions. Some of our more basic, primeval emotions, such as fear, evolved as crucial survival mechanisms, enabling our ancestors to avoid injury and death. Others were more closely tied to our ability to form the social relationships needed for the preservation of our genes in the evolutionary process. Neuroscientific research has demonstrated that multiple neuronal systems have evolved to translate sensory inputs into responses via neurochemically-mediated emotions. Since our neurochemistry is genetically inherited and contributes to forming our personalities, individuals differ in the way they experience emotions and respond neurochemically to external occurrences. Chapter 3.5 will explore further the relationship between inherited and acquired traits, as well as the notion, and development, of morality in relation to these.