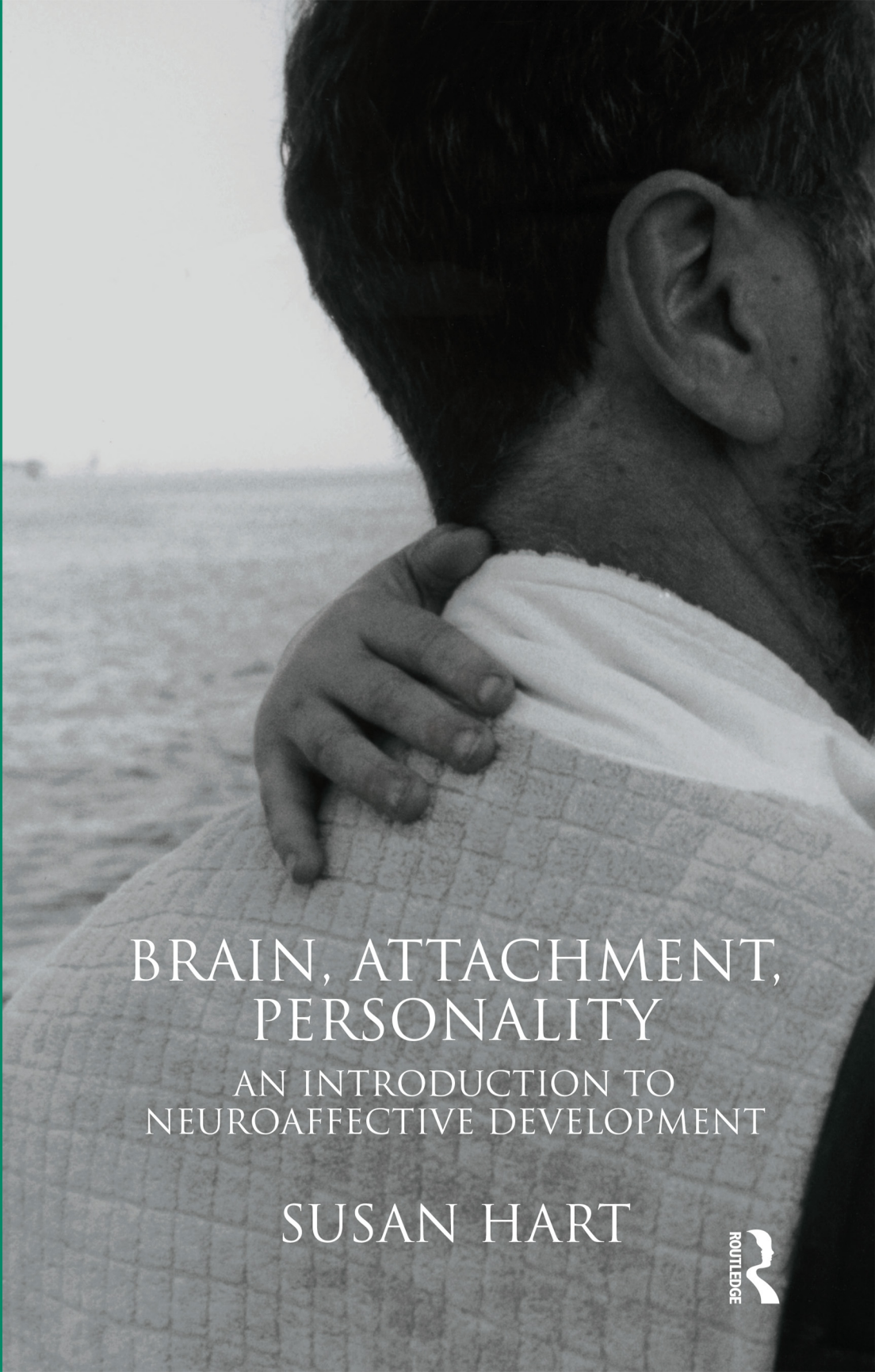

BRAIN, ATTACHMENT, PERSONALITY

AN INTRODUCTION TO NEUROAFFECTIVE DEVELOPMENT

SUSAN HART

ROUTLEDGE

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An Introduction to Neuroaffective Development

Susan Hart

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Some six years ago, when I was working at the psychiatric children's ward at Gentofte County Hospital in Copenhagen, I told my supervisor at the time, Administrative Chief Doctor Karl Johan Rump, about my enthusiasm for the integration of recent neuroscience and developmental psychology. He shared my excitement, a rare occurrence at the time, and helped motivate me to continue down this path, for which I am grateful. I would also like to thank Chief Psychologist Rikke Schwartz, whom I met through my work at Gentofte County Hospital, for her important contributions to my understanding of the link between relationships and the development of personality disorders. Thanks are also due to body psychotherapist Marianne Bentzen, who originally introduced me to the latest developments in neuroscience, and who has remained a faithful source of inspiration and discussion partner during the writing process. Both Rikke and Marianne have been tremendously helpful in relation to the creation of this book and have patiently offered relevant comments and corrections. My secretary, Hanne Mølgaard, also deserves my heartfelt thanks for her loyalty, hard work, and patience in typing up the manuscript. Finally, I would like to thank Henriette Thiesen, my editor at the Danish publishing

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Thou straggler into loving arms,
Young climber-up of knees,
When I forget thy thousand ways
Then life and all shall cease.

[From "A child", by Mary Lamb (1765–1847)
The Oxford Book of English Verse: 1250–1900, 1919]

ABOUT THE AUTHOR

Susan Hart, a psychologist, has been the director of a municipal family therapy centre; her experience also includes work in municipal social services and in a children's psychiatric ward. Today, she has an independent practice and works mainly with professional supervision of psychologists, visiting nurses, and social workers in child and family departments, personnel in child psychiatric wards, and advisers to foster families. Susan Hart is the author of several books and articles on neuroaffective developmental psychology, and frequently gives lectures and courses on the topic.

FOREWORD

> "I hope I have indicated that we are currently at one of the most exciting junctures in the history of our field. We are now, or soon will be, in a position to begin mapping relations between individual differences in early attachment experiences and changes in neurochemistry and brain organization. In addition, investigation of physiological "regulators" associated with infant-caregiver interactions could have far-reaching implications for both clinical assessment and intervention"
>
> (Main, 1999, p. 881)

During my many years as a clinical psychologist working with adults, families, and children, I have always marvelled at the way that personality patterns appear as a kaleidoscope of life experiences. I have never doubted the link between family dynamics, interactions, personality, and inner psychological structure, and it has been equally clear to me that the personality is constructed within the context of social interactions or attachment. It has, however, been difficult to describe the processes of transmission from the interpersonal to the intrapsychological. It is not always an easy

task to document the relationships between observable behaviour and personality structure.

Van Ijzendoorn (1995) used the term "transmission gap" to describe the difficulty of explaining the transmission between the intrapsychological and interpsychological fields. The theories of attachment and development psychology have helped me to gain an understanding of the nature of this transmission. In particular, John Bowlby's epigenetic understanding has contributed to my learning process. He pointed out that children's psychological development takes place in a dynamic interaction between genetic predispositions and the environment, which shape each other in a mutual process that begins at conception. Bowlby's work was done during a very fruitful period for the development of psychoanalytic theories in the mid 1900s, which sought to understand the individual as part of a system instead of viewing him or her as an isolated energy system. Bowlby had a very wide field of interest—animal studies, systemic theories, cognitive psychology, and behavioural psychology—and he integrated these theories in order to bring Freud's motivational theories into a dynamic relational context. He developed his theories from the mid 1950s and stands, in many ways, as the founder of developmental psychology. He developed his theories on the basis of mammalian attachment behaviour and pointed out that maternal care and a sense of security form the foundation for psychological development. He viewed the environment as a crucial factor in shaping the personality, and his theories made him the target of sharp criticism from psychoanalytic circles in England.

The integration of developmental psychology and recent neuroscience

According to Bowlby, infants organize their experiences with their closest care-givers in so-called "internal working models" at an early stage. These internal working models become critical for the children's formation of future relations and form the basis for their future view of everything that happens in life. This view is shared by many developmental psychologists, including Daniel Stern, who has been the most influential developmental psychologist of the

past twenty years, partly due to his theories on self-experiences and affect attunement.

John Bowlby did not have the opportunity to integrate his theories with sophisticated knowledge about the brain, but he was aware that a deeper understanding of the complexities of normal development *vs*. psychopathology would only be possible through an integration of developmental psychology, psychoanalysis, biology, and neuroscience (Schore, 2000a,b).

Sigmund Freud also hoped for a closer link between biology and psychology, but he, too, lacked the opportunity. When setting out, he lacked both a psychological theory and a neuroaffective theory, and he chose to restrict himself to psychology. In his letters to Wilhelm Fliess, he expressed his desire to unite the two disciplines, and he did send Fliess a draft, which was published in English in 1950 as "Project for a scientific psychology" (Freud, 1954). In this text he sought to dissolve the duality that continues to separate psychology from neurology to this day. Freud never gave up the notion that one day psychoanalysis would merge with neurophysiology. He was convinced that the science of psychoanalysis could be reconciled with biochemical and neurological theories, although the time was not yet ripe, and he cautioned against allowing neuropsychological theories to take over with reductionist explanations on purely biochemical or neuropsychological terms. In a more current context, Glenn Gabbard (1992) has issued a similar caveat: "To lose the psychodynamic perspective is to lose the complexity and richness of human functioning in the quicksand of neurotransmitters and molecular genetics" (pp. 996–997). Surely, by now, we should give up a view that reduces the mind to mere biological processes, and be ready to integrate neuroscience and psychology with science and culture, instead of continuing to fluctuate between an aetiology that is either purely sociopsychological or purely biological in nature.

Combining the wisdom of developmental psychology with neuroscience poses a challenge to both disciplines. Psychological theories are often based on philosophy and consist of observations, analyses, and interpretations. Neuroscience is related to exact and objective knowledge, preferably validated knowledge. Due to its philosophical moorings, psychological knowledge is often difficult to objectify and standardize, while science is often rigid, difficult to

subjectify, and misses the wisdom contained in the philosophical considerations. Thus, an integration of the two domains will be a challenge for both.

Although modern neuroscience still has a long way to go before it is able to offer a complete understanding of neurological processes, much progress has been made, and new information continues to be added every day. Today, neuroscience has much to contribute to our understanding of affects, emotions, and personality. New imaging technology—SPECT, PET, MEG, MRI, and fMRI—has enabled us to measure activity in the living, active brain. Granted, brain-imaging technology is not yet accurate enough, in particular when it comes to studying the many subcortical neural circuits that control our fundamental psychological processes. Part of the reason for this is that the circuits in this area of the brain are very closely interwoven, especially in the deeper-lying areas in the brain stem. The images we obtain with modern imaging techniques are not snapshots, but depictions that represent complex data, and that require a great deal of statistical processing. The data collected in this manner are difficult to interpret, even for experts.

Despite its relatively short existence, developmental psychology also has much to offer neuroscience, because it describes the relationship between interpersonal dynamics and the processes of personality formation. In my view, to understand the mature and fully developed brain we must first understand the gradual development of the brain, a process that takes place in close interaction with the infant's care-givers. Much research is still needed to understand the developing human brain, while we now have a far greater body of knowledge about the mature brain. We have only just unearthed the Rosetta stone of neuroaffective understanding, but I am confident that, within the foreseeable future, we shall be able to decipher the "hieroglyphs" and gain insight into the relationship between neurons and nurture, and the way that nature and nurture affect each other in an interdependent process.

Neuroaffective developmental psychology

My aim with this book is to bring together theories concerning the relationship between brain functions, behaviour, and personality by

exploring the way the brain matures in close interaction with the social and physical environment. I saw an opportunity for theoretical integration some twelve years ago when I first encountered the latest developments in neuroscience as presented by Antonio Damasio and Joseph LeDoux in particular. Although the literature at the time was limited, my encounter with the works of these two scientists inspired me to address the integration of neuroscience and the theory of developmental psychology. This topic has continued to engage me ever since, and today I am even more convinced that a combination of the two bodies of theory would be both important and groundbreaking.

In their first books, Joseph LeDoux and Antonio Damasio offered a thorough introduction to certain aspects of the emotional or feeling brain. Their experience was based partly on work with adults with brain injury, partly on laboratory experiments with animals. At the time, there were no published works concerning the impact of the environment on brain development. In his 1994 book, *Affect Regulation and the Origin of Self*, Allan Schore made a first attempt at integrating and linking these theoretical fields. Schore had completed the important task of assembling research articles that indicated such links. Schore's work was and is the foundation for my own attempts to integrate the theories of neuroaffective development with the understanding that characterizes relational development psychology; an integrated theory that I have called "neuroaffective developmental psychology".

In the years to follow, it became common to integrate attachment and psychoanalytical theory, and to incorporate neuroaffective knowledge in this integration. In the 21st century, Peter Fonagy has been a particularly outstanding figure. To me, he has been a great source of inspiration in my efforts to expand this integration.

As a psychologist, I had always believed that it was only in the human sciences that theories were difficult to validate, and where theories had to rely on conviction to a certain degree. I was convinced that the natural sciences were exact and, thus, made it far easier to find precise and validated answers. However, after studying neuroaffective literature, I find many of the theories confusing, complicated, at times self-contradictory, and very much the object of polemics and debate. Recent neuroscience, with its "rapprochement" to developmental psychology, depends, like any science, on

the cumulative effort of thousands of scientists. We still have a long way to go before we can move from general hypotheses to an exact, validated theory on the relationship between brain functions, behaviour, and personality. For now, we must be cautious and approach the theories as hypotheses, some of which might, one hopes, one day be validated. This book does not offer exact answers; rather, it describes hypotheses formulated by scientists with many years of experience in their field and offers additional hypotheses based on this understanding in combination with my own clinical experience. In all likelihood, the hypotheses will have to be readjusted and altered as neuroscience progresses further. For now, this attempt at integration should be viewed as a theory in line with other preliminary theories in an ongoing process of change and refinement.

An outline of the book

This book is intended as an inspiration and as an introduction to what I have called neuroaffective developmental psychology. As an underlying theme throughout the book, I seek to emphasize the importance of attachment for the formation of personality in all its diversity. The book presents a merger of systems that are not normally brought together in a structured psychodynamic context. Thus, the book operates on three levels: a neurobiological level, an intrapsychological level, and an interpersonal level.

This combination of different bodies of theory has made it a constant challenge to maintain a consistent terminology, in particular because certain concepts are not in themselves very clearly defined. One key example of this is the lack of a clear distinction between the concepts of affect, emotion, and feeling. In this context, I use "affects" to refer to the underlying neurological basis for the formation of emotions, while "emotions" and "feelings" are used synonymously. Bowlby introduced the term "internal working models", while later authors, including Daniel Stern, use the term "internal representations", which is also the term that I use. The terms "self" and "personality" may also be hard to distinguish from one another, and in this book they are used synonymously. Translated quotes are marked "translated for this edition". The brief

stories about Matt in Chapter Ten are fictitious, while other case stories without a source reference stem from my clinical practice.

The book focuses on the brain structures that are essential for the formation of relationships, personality development, and emotions. It attempts to provide an understanding of the way that the uniquely human nervous system develops capacities for empathy, mentalization, and reflection that enable us to address such aspects as past and present, interpersonal relations, ethics, art, and aesthetics. I have endeavoured to make the text meaningful and comprehensible in order to make the topic interesting and inspiring to the reader and to spark an interest in further studies. Each chapter seeks to present the necessary knowledge for an understanding of our inherent neural basis for interpersonal interactions. The individual chapters can be read independently. Some passages will be more demanding than others and may be safely skipped without rendering the rest of the text meaningless. The outline of the book is as follows:

Chapter One discusses the relationship between nature and nurture. Both nature and nurture have substantial impact on brain development and, hence, on personality. This chapter looks at the mutual interactions between these two factors. The chapter also discusses Paul MacLean's model of the triune brain, which states that the brain has evolved in a hierarchical manner and can be divided into three distinct but interrelated layers, which, roughly put, handle sensations, emotions, and cognition. Since the environmental influences begin while the foetus is still in the womb, Chapter Two discusses the preconditions for brain plasticity, environmental influences on the nervous system during gestation, and the importance of embryology for the development of the nervous system. In order to provide an understanding of the complexity of the brain and its "landscape", Chapter Three takes the reader through brain anatomy, biology, and chemistry, as well as the maturation process of the brain. Chapter Four discusses the plasticity of the brain, but also the assumption that there are so-called windows of opportunity that are only open at certain times during the maturation process. This chapter discusses various theories concerning phases and stages, critical and sensitive periods. Since the human nervous system relies on outside influences to mature, Chapter Five examines the basis for the attunement of the nervous system through

rhythm and resonance phenomena. As mentioned above, the brain may be divided into three levels, and these are the topics of Chapters Six, Seven, and Eight. Thus, Chapter Six describes the sensory brain, the lowest level in this triune model, Chapter Seven addresses the emotional level, the middle of the three levels, and Chapter Eight discusses the rational level, the top level of the triune brain. The brain is composed of neurochemical compounds that affect motivation, stress-management skills, and emotional flexibility, and Chapter Nine addresses the most important of these messengers: neurochemical regulation is crucial for the development of personality and is achieved through interactions with the external environment. The current view is that mental processes in the brain are based on the establishment of neural circuits, and that certain brain structures activate certain emotional categories. Chapter Ten examines the main affect-regulating circuits, although our knowledge about these circuits is far from complete. Men and women display behavioural differences, and sex hormones play an important part in brain development and are released at specific developmental stages. It is difficult to find distinct anatomical differences between male and female brains, but there are some minor deviations, and both the impact of sex hormones and these minor differences in brain anatomy may explain certain sex-typical features, which are described in Chapter Eleven. As mentioned earlier, the vertical structure of the brain may be viewed as triune, but the brain is also lateralized and consists of two separate hemispheres. The two hemispheres are in charge of different functions, and Chapter Twelve describes this functional lateralization, the integration of the brain through the corpus callosum and anterior and posterior commissures, and the effect of lateralization on personality functions. All personality development and learning are based on memory functions. Chapter Thirteen describes various theories on memory functions and our many memory systems, which are mutually integrated in the triune brain. Self and consciousness are often treated as self-explanatory terms, but they are essentially symbolic markers of deep and complex internalized sensations and actions. Chapter Fourteen describes various representations of consciousness or mental organization, partly based on the notion of the triune brain, and addresses the role of these levels as prerequisites for the emergence of the ego or self that we know from our waking state.

The day and the hour

When
at what day
at what hour
surely there must have been
a day an hour
when development
however slowly
imperceptibly
was initiated
did we stop
being who we had been
and became those
who have already
begun
not to be.

(Maria Giacobbe, "De fire læretider", 1981,
translated for this edition)

CHAPTER ONE

The dynamic brain in a dynamic environment: an epigenetic understanding

> Just as everything about our minds is caused by our brains, everything about our brains is ultimately caused by our evolutionary history. For human beings, nurture is our nature. The capacity for culture is part of our biology, and the drive to learn is our most important and central instinct
>
> (Gopnik, Meltzoff, & Kuhl, 1999, p. 8)

From the moment of conception there is a dynamic interaction between our genetic and hereditary properties and our environment. From birth, infants are predisposed to establish attachment and to engage in interactions with their care-givers. They initiate and control interactive situations and have an intuitive basis for sharing other people's feelings and grasping their intentions. Three-week-old infants are able to imitate other people's facial expressions, and two-day-old infants are able to reliably imitate a face that smiles, frowns, or looks surprised (Field, Woodson, Greenberg, & Cohen, 1982; Meltzoff & Moore, 1977; Stern, 1985).

The discussion of nature *vs.* nurture seems never-ending and is, in many respects, meaningless, since nature and nurture can be only expressed through intimate interaction. Nature and nurture

are expressed at the moment of conception, throughout gestation, during childhood and youth, and in adulthood. A mother, father, or other primary care-giver affects the development of the infant's affect-regulating system, which is neurally conditioned, and which later helps regulate other attachment functions. John Bowlby viewed attachment as the part of human biology through which social bonds are enacted. The attachment process enables the development of complex mental functions through complex actions from the primary care-giver. Many of these mental functions are uniquely human (Fonagy, Gergely, Jurist, & Target, 2002).

In this first chapter, I address the issue of nature *vs*. nurture and discuss man's inherent biological properties as tailor-made to provide us with the capacity for interacting with our environment or culture; I also look at the evolution of the human nervous system. Paul MacLean's view of the triune brain will be incorporated in a discussion of the human nervous system as consisting of different forms of mentalization, which are capable of functioning independently but usually function in close interaction through a sprawling and tight-knit network of neural paths. At the end of the chapter, I offer a brief introduction to brain development from birth and to the importance of stimulation as the key driver of, and condition for, this development.

Nature and nurture

Howard Gardner (1996) notes that our potential capacities are expressed through the basic structures of the brain, i.e. through heredity, but that environmental factors mobilize these latent capacities by altering the efficiency of the existing neural pathways and causing new behavioural patterns to emerge. We are born with physiological and psycho-biological equipment that must be exposed to human culture in order to reach its potential; our innate potential can only be realized through culture. Our life experiences are critical for the differentiation of brain tissue. The innate structure of the nervous system determines children's interactions with their surroundings, and the resulting responses in turn affect the structure. Thus, there is no inside and outside in relation to the nervous system; as Daniel Stern (2001) has pointed out, we are all born to engage in each other's nervous systems.

The neural structure determines the potential, but experience gives it its specific form. As humans, we are predisposed to develop language, for example, but the specific language that we acquire depends on our environment. The specific information derived from experiences is incorporated into the neural structures. The structure that the nervous system has from birth determines the opportunities and the changes that environmental influences can lead to. Nature and nurture are not each other's opposites; they interact in an interdependent process and are inseparable. Some genes only express themselves under certain life circumstances, and individuals who are particularly genetically vulnerable are also more receptive to psychological damage from environmental factors. We respond differently to similar stress stimuli, and environmental factors affect our personalities in different ways (Rutter & Rutter, 1997).

The human biological capacity for participating in culture

No individual can be divorced from his or her history and culture; we are not fully contained within our own skin. We have a biological capacity for taking part in social interactions and communication because we are born with the predisposition for forming attachments and interacting with our care-givers. Humans are social beings, and our psychological functions depend on interactions and transactions with the social environment during infancy. Biology does not determine a person's actions and experiences—biology determines what is possible. Culture shapes the human mind. It is impossible to determine how much of a child's psychological function is the child's own, and how much is a product of the child's relationships. Culture consists of an infinite number of ways of being together, through language, narrative explanations, etc., in a shared life where people rely on each other. Culture makes actions meaningful by imbuing these actions with intentions within a particular interpretive system that is active from birth (Bruner, 1986). The child arrives with certain innate abilities for participating in culture, and the resulting life and personality are derived from a developmental process that unfolded under particular historical circumstances.

The human brain is the most complex and plastic natural system in the known universe. Humans and mammals have many instinctive operational brain systems, but in the mature adult human brain the instinctive processes are difficult to observe because they are no longer expressed directly but are filtered and modified by higher cognitive activity. The instinctive operative systems form the basis for our sophisticated abilities. The human ability to acquire language, for example, is genetically determined, but the genetic programming concerning language is unusually open and susceptible to environmental influences. The construction of mammalian brains is governed by genetically dictated rules that include innate development programmes. Specific genes are expressed at specific developmental stages. There are programmes for selective cell death, which selectively kill off surplus neurons in order to make room for new and more advanced possibilities. These processes are controlled by chemical substances and molecules that foster optimal neuronal growth patterns. Darwin (1872) mentioned that certain primary emotions arose through genetic dictate, but that they matured and were shaped by environmental influences through personal experiences throughout the lifespan. Neuronal migration and the formation of billions of synapses follow a set of general principles, which cannot be exclusively under genetic control because we simply do not have that many genes. Our genes enable us to feel and behave in certain ways, and cultural learning enables us to effectively utilize these abilities and navigate in a complex world. These trends are combined in motor skills, sensory perception, affect, motivation, emotion, thinking, behaviour, etc.—all the aspects that we define as personality.

The relationship between genetic predispositions and environmental factors

Many hereditary phenomena require transactions with the environment in order to be expressed, and the care-givers' behaviour plays an important role in determining which hereditary predispositions actually unfold, and how (Plomin, 1983). Heredity defines the basic parameters for our development, but many other factors determine the actualization and expression of these hereditary elements. All learning depends on a genetically programmed capacity for

learning and involves environmental influences on hereditary properties. Genes contribute to, but do not dictate, the formation of synapses. Schizophrenia is a case in point: if one identical twin develops schizophrenia, the other twin has a high likelihood of also developing the disorder. On average, about one per cent of the population develops schizophrenia. The non-identical twin of a person with schizophrenia has a seventeen per cent risk of also developing the disorder, while the risk for a non-twin sibling is nine per cent. The risk that the identical twin of a person with schizophrenia also develops the disorder is only about fifty per cent, although they share the same genetic material (LeDoux, 2001; Plomin, 1999).

The Finnish psychologist Pekka Tienari (1991) compared adoptive children who had schizophrenic birth mothers with adoptive children whose biological parents had no psychological disorders. He found that the adoptive children with schizophrenic birth mothers were somewhat more likely to develop a personality disorder than the children in the other group—but only when they lived in homes that were considered emotionally dysfunctional. Even a high genetic risk does not necessarily mean that the consequences of a given behaviour are linked with this risk. If, for example, child abuse were found to be conditioned by genetic factors, the damage that the child suffered would still happen, via the child's loss of trust in the environment. Similarly, criminal behaviour only seems to be related to genetic risk if the child spends the first few years of life in a dysfunctional family. Whether the genetic risk manifests itself depends on the quality of the child's family network (Fonagy, 2003).

Genetic factors and the way they are expressed are more amenable to environmental influences at certain developmental stages. These are often referred to as particularly sensitive or critical periods. Genes do not exercise their full influence at birth, but are boosted periodically by maturational progress and through interactions at the various developmental stages. The human brain develops about seventy per cent of its final content and potential after birth (Schore, 1994).

Certain innate dispositions are more susceptible to outside influences than others; for example, experiments with monkeys have showed that monkeys' innate fear of snakes requires not only exposure to a snake but also to the mother's expression of fear when

encountering the snake. A single exposure is sufficient to trigger fear in the young monkey, but without the mother's fear response the young monkey's innate fear will not be activated. Thus, the unconscious reaction to snakes has both an innate and an acquired component, and these are interconnected somewhere deep inside the unconscious system (Damasio, 2003). The biological factors create the predispositions and conditions for our interactions with our surroundings, which in turn shape our behaviour. In addition, some of these elements may become symbols, laden with meaning. For example, snakes, bears, and other powerful animals play an important role in the myths and storytelling of most communities. When these symbols are applied they affect us on a deep emotional level.

Our genes are environmentally responsive

Edelman and Tononi (2000) point out that the specific environment that a child is born into determines which neural networks and synapses are formed and strengthened. Already, at birth, the stimulation that the child is exposed to initiates and strengthens certain specific patterns of neural activity. In this manner, genetic and environmental factors interact at every stage of brain development. The environment plays a key role in the establishment and strengthening (selection) of synaptic connections after birth. Because the human brain is so relatively unfinished at birth, the care-givers have a major impact on the detailed structure and functions of the brain. The care-givers affect the unfolding of the brain's genetic programmes through experience-dependent influences and development. The genetic potential plays out on a background of specific social experiences that impact the way that neurons interconnect. Human contact creates neural connections. For example, although the ability and desire for play is a genetically programmed behaviour, these traits are only expressed under the right circumstances. Anxiety and hunger, for example, inhibit play. Most mammals only play when they are in a warm, supportive, and safe setting with engaged and involved care-givers. Thus, environmental stimuli regulate the anatomical and cellular organization in the developing nervous system (Schore, 1994).

Previous experiences affect development on both a psychological and a neurophysiological level. The infant's early care-givers

help create a personality foundation, which enables the infant to engage in many other future human relations. The quality and nature of these relationships determine the infant's opportunity for unfolding his or her genetic potential.

An example of the interdependence of nature and nurture is illustrated in experiments with rhesus monkeys, where Stephen Suomi (1985, 1991, 1997, 2000) studied different monkey personalities. Suomi found that young monkeys often display personality features that resemble those of their fathers, even though, in many cases, they had never met their fathers. He also found that maternal care can effectively turn particularly vulnerable and unfortunate personality features around and that such traits as shyness or a reactive temper are innate features that may unfold in advantageous or disadvantageous ways, depending on the monkey's upbringing. Thus, temper is hereditary, but open to both positive and negative influences through environmental factors—*our genes are environmentally responsive*. Suomi found that a caring rhesus monkey mother might make up for difficult temperamental aspects; for example, by taking the time to teach the young monkey coping strategies. The young monkey learns how to seek support from others, and as an adult it will often command a high position in the group hierarchy. In monkeys, the effect of early experiences may be reversible, even in extreme cases, although this is not an easy process. In humans, too, the early social environment has substantial impact on subsequent behaviour, and even the "best genes" in the world cannot ensure that an individual will grow up to be socially competent if he or she is raised in a harmful environment. On the other hand, even the best or the worst environment imaginable cannot prevent certain innate features from appearing at specific times in the child's development and being integrated into the child's behavioural repertoire.

Vulnerability and environmental influences

Temperamental components such as passivity or hyperactivity, for example, may be induced by either innate or environmental manipulations. Several studies (including van Ijzendoorn, Goldberg, Kroonenberg, & Frenkel, 1992) conclude that parental factors have a much greater influence on the infant's attachment pattern than the

infant's temperamental characteristics. There is also documentation that innate factors help determine an infant's attachment competencies in the form of secure or insecure attachment (Brodén, 1991). Children are born with different temperaments, which affect their encounter with the world.

As Allan Schore (1994) has pointed out, humans have an innate template for engaging in interactions with a primary care-giver and for unfolding their potential through specific interactions with this person. The mother regulates interactions with the infant, regulates the infant's endocrine and nervous system, and acts as an external regulator of the neurochemistry in the infant brain, as has previously been pointed out by Plomin (1983), Hofer (1983), and others.

Sroufe (1979, 1996) has studied infants with depressed, inattentive mothers and found a clear connection between the degree and character of the interaction and a progressive deterioration of the conditions of these infants. At three months, the infants' responses were unremarkable, at six months, they seemed anxious or passive Around the age of one year, half the children showed an insecure attachment to their mothers, and at age eighteen months all the children had an insecure attachment. The mother's personality has been found to be a more reliable predictor of the child's future attachment pattern than the child's own temperament. The child's temperament—responsiveness, activity level, attention management, etc.—influences the expression of a particular attachment pattern but not the nature of the pattern. Other studies have shown that parents may have difficulty establishing a safe and secure base for children with difficult innate temperaments: for example, children who are difficult to regulate or children with an innate temperament that differs from that of their parents (Belsky & Isabella, 1988; Chess & Thomas, 1987; Karen, 1998).

According to Rutter and Rutter (1997), there is no evidence that specific behavioural patterns are hereditary. From birth, children have individual temperamental differences, and some infants are more amenable to emotional regulation than others. Temperamental differences affect the interaction with the care-giver, and difficulties in the interaction may stem from the mother's personality, the child's personality, differences between the two, or social and societal conditions. The parents' appreciation of the child may be

weak, and the interaction may damage the development of the neural circuits.

Humans are social creatures—hence we are also the source of each other's stress. Stress often has roots in close relations and has a substantial impact on brain development. Abuse or neglect in the early stages of life in combination with innate vulnerability in the child has been found to increase the risk of a deterioration of the stressful state. Children who are prone to developing aggressiveness will unfold these aggressive tendencies if they grow up in high-risk families. Children with an innate disposition for depression will develop depression if they are unable to cope with abuse or neglect and chaos.

The way that children process experiences and perceptions of the environment has a great impact on their behaviour, including the expression of genetic dispositions. Internal and external stimuli are crucial to brain development, and such factors as hormones, stress, learning, social interaction, etc., will affect the neural structure. The child's experiences and evaluations are closely associated with attachment relations, and the quality of early relationships is a key influence on the child's processing capacity. Children's understanding of their surroundings is more amenable to modification than the environment itself or the genes with which the environment interacts (Fonagy, 2003).

The triune, hierarchical brain

In 1949 Paul MacLean (1967, 1970, 1973, 1990) published his first article as a precursor of the theoretical construction that he would continue to elaborate on throughout the 1950s and 1960s. In 1970 he had completed a model of cerebral organization that he called "the triune brain". MacLean sought to point out anatomical structures and neural circuits that are crucial to our emotions. He was inspired by James Papez, who had suggested a functional split between the cognitive and the emotional processing of sensory input as early as the 1930s. MacLean divided the brain structures into three tiers, which he viewed as quantum leaps in the evolution of the human brain. In his view, the brain had evolved for millions of years from the bottom up, with higher centres evolving as superstructures on top of lower and older sections (Figure 1.1). Throughout the 1970s

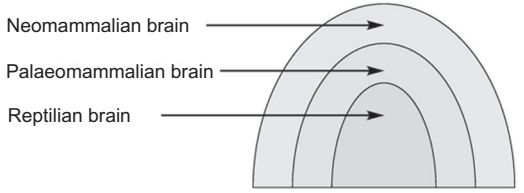

Figure 1.1. The three levels of the triune brain.

and 1980s he continued to refine this theoretical construct, and in 1990 he published his principal work, *The Triune Brain in Evolution: Role in Paleocerebral Functions.*

MacLean saw the three cerebral structures as essentially different both structurally and chemically, and he viewed them as evolutionarily distinct. They have vast neural interconnections and function as three brains in one. He uses the term "triune" to emphasize that the whole is greater than the sum of its parts because the exchanges between the three brain structures contain more information than the sum of the individual brain structures would if they operated independently. MacLean compares the structure to three individual but interconnected computers, each with its own intelligence, its own subjectivity, its own sense of time and space, its own memory, its own motor functions, etc. Despite the close links between the three cerebral structures they all function as partially independent systems. The lines between the three structures are somewhat blurred, however, and it may be difficult to define a specific function as belonging exclusively to one single structure. MacLean divided the three brain structures into three different mentalization forms and labelled the most primitive layer protomentation, the middle layer emotomentation, and the third layer ratiomentation. These three forms of mentation exist on three different levels in the brain, which he labelled the reptilian brain, the palaeomammalian brain, and the neomammalian brain.

The reptilian brain

The most primitive layer, the reptilian brain, processes instinctive impulses and handles basic motor planning. The term reptilian brain stems from the assumption that this brain was predominant

in the age of the reptiles. This part of the brain consists of instinctive functions and very primitive reflexive "emotional" reactions such as seeking, aggression, sexuality, and certain aspects of anxiety behaviour. In the modern human brain, this structure may be related to the brainstem and middle brain structures, which regulate breathing, heart rate, and other vital functions. The reptilian brain controls stereotypical reactions and movements, receives sensory input, and co-ordinates movement. It has a limited cortex and is therefore not capable of learning to handle more complex novel situations.

The palaeomammalian brain

The next layer, the so-called palaeomammalian (older mammalian) brain, is also known as the limbic system. In MacLean's view, this brain became predominant at the stage in evolution when the first mammals appeared on the scene. The older mammalian brain made the basic reptilian affects more subtle through the development of social emotions and generally added further mental and non-reflexive activity to the brain's repertoire. In time, the limbic system also provided memory and the possibility of learning emotional responses, which added a new dimension to situations that involve choice. Both the reptilian brain and the palaeomammalian brain lack the neural circuits required for verbal communication.

The neomammalian brain

The third layer and the latest evolutionary stage is the neomammalian (new mammalian) brain. The explosive growth that took place late in evolution is believed to have been one of the most dramatic examples of evolutionary transformation known in anatomy. This area, which mainly consists of the neocortex, processes mental and cognitive reasoning. The neocortex arose millions of years after the limbic system, as the mammalian brain evolved further. The neomammalian brain is also called "the thinking brain", and further development of the neocortex has added what is specifically human. The neocortex contains the areas that integrate and make sense of sensory experiences. It enables a more complex emotional register, where an emotion is combined with the

thoughts concerning this emotion. This is the area that enables abstract thinking, the creation of abstract fictitious worlds where emotional values are attached to real-world phenomena. It expands a given emotion with the thoughts concerning it, which makes it possible, for example, to have feelings concerning ideas, art, and symbols and enables us to imagine what others are feeling. The evolutionary advantage of the neocortex must have been the ability to strategize and make long-term plans. While limbic structures give rise to sensations of pleasure, fear, grief, sexual desire, etc., the neocortex enables us to process this emotional content. The separation of the limbic structures from the neocortex corresponds to the separation of feelings from knowledge.

The hierarchical brain

The extensive functional interaction between the three cerebral layers defined by MacLean, despite their respective "focus areas", has given rise to criticism (LeDoux, 1998). Many neuroscientists reject the model as overly simplistic, because they see it as undermining the understanding of the brain as a highly integrated entity. Despite the criticism, I choose to use the model as a useful synthesis that may help bring order to the many complicated structures of the brain. For, as Professor of Psychobiology Jaak Panksepp (1998) writes,

> Although the triune brain concept is largely a didactic simplification from a neuroanatomical point of view, it is an informative perspective. There appear to have been relatively long periods of stability in vertebrate brain evolution, followed by bursts of expansion. The three evolutionary strata of the mammalian brain reflect these progressions. [p. 43]

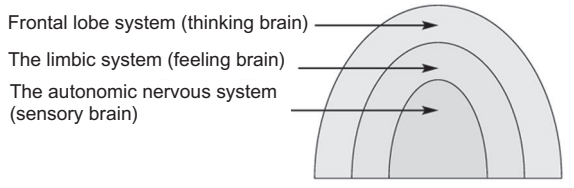

Figure 1.2. The triune brain.

Thus, the model is merely a "map", which should not be mistaken for the "landscape"; it is not a snapshot of the brain.

Thus, in a somewhat simplified version, the hierarchical functions of the brain may be organized as described above. In a simplified sense, the hierarchical system of the brain implies that higher-order functions are always based on lower-order functions, while lower-order functions may be independent of higher-order functions. As Damasio (1994) points out, nature has not simply superimposed the neural structures for logic and rational thinking on top of the existing structures for physiobiological–sensory regulation and emotional structures; rather, these new structures are developed from and together with the older structures. Thus, it is not only the neomammalian brain that has evolved, but also structures in the palaeomammalian brain and in the reptilian brain. Memory functions were not always a part of the limbic system, and the limbic system has evolved in terms of both mass and neuronal density.

The emotional systems probably hold a key position in the imprint of many higher and lower brain activities. Owing to the interactions of the limbic systems with higher brain regions, no emotion is unaccompanied by thought, and many thoughts produce emotions. The innate emotional systems interact so intensively with higher brain systems that the normal animal brain is probably incapable of having an emotional condition without cognitive processes (Panksepp, 1998). Owing to the interaction of the limbic system with lower brain regions, there are no emotions without physiological or behavioural consequences, and many of the resulting bodily changes might also regulate the tone of the emotional system in a feedback loop.

In this section, I have described the hierarchical brain and the interactions of the various parts of the brain from a phylogenetic point of view, based partly on Paul MacLean's theory of brain evolution. In the following section, I describe some of the general considerations concerning brain maturation throughout the lifespan—the ontogenetic development.

The "user-friendly" brain

At the beginning of the previous century, the English neurologist John Hughlings Jackson (1835–1911) pointed out that the human brain consists of functional hierarchical levels where top-level

functions are volitional and able to inhibit non-volitional, lower functions, although they are not unaffected by these lower levels. Through distinct developmental stages, the structures that develop early in life are progressively subordinated and incorporated into later developing structures, which increases the brain's complexity. The functions that were present at the previous levels become subordinate to the higher, later emerging levels (Schore, 2003b). As John Bowlby pointed out, this hierarchical structure makes the brain more adaptable and efficient, but it also renders the developing nervous system more vulnerable and susceptible to the risk of actually losing efficiency. As development progresses, ever more brain structures can be activated simultaneously in support of each other, but there is also a risk of brain structures dissociating or competing against each other (Mortensen, 2001).

All behavioural changes are reflected in the nervous system, and all major changes in the nervous system are reflected on all neural and behavioural levels. Everyday sensory experiences, sensory deprivation, and learning may weaken certain synaptic connections under certain circumstances, or strengthen them under a different set of circumstances (Kandel, 2005). External stimuli influence the brain's affect-regulating systems, which in turn affect hormones and neurotransmitters. The social environment changes during infancy, which leads to the disorganization and reorganization of brain structures. The range of interactions between care-giver and infant is imprinted on the infant's developing nervous system. Various types of stimulation trigger affective interactions and are embedded in certain physiological and psychobiological patterns in the infant's nervous system. Early affective exchanges between infant and care-giver form the basis for the self-regulating mechanisms that remain an important organizing principle throughout life (Krystal, 1988; Schore, 1994).

Initially, infants express themselves through reactions that are both created by innate temperamental contours and triggered and shaped by external stimuli, and, as previously mentioned, they adapt in a number of ways. Some infants handle affect regulation with greater ease than others, and the ability to maintain flexible and organized behaviour in the face of high levels of arousal or excitation is essential in relation to the individual differences in personality organization (Sroufe, 1996).

All synapses throughout the nervous system are open to experiential modification. Emotional systems develop through association or classic conditioning, including the avoidance of unpleasant experiences and attraction to pleasant ones. The activation of neural circuits has a direct impact on the development of connections in the brain. The specific information that is derived from experience is incorporated into the neural structures, including the formation of new synaptic connections and cellular changes.

The brain is simultaneously resilient and malleable

In many regards, the brain is plastic, but in other areas it does seem to adapt to its environment so specifically that certain behaviours become change-resistant. Thus, one ongoing discussion concerns the relationship between the so-called "resilient brain" (limber, elastic) and the "malleable brain". Resiliency implies that the brain is able to recover from a stressful period and return to a previous condition like a seed that has been stepped on. Malleability implies that the brain is shaped by the influences it receives, and that it is able to adapt to its surroundings, like putty. The emerging consensus seems to be that the brain is characterized by plasticity as well as malleability. It adapts, but not under all circumstances. The human brain is designed to mature on the basis of experiences. Early neglect and stress causes adaptive adjustments in neural development. The evolutionary benefit would be to prepare the adult brain to survive and reproduce in hazardous surroundings. There may be a high price to pay if the child is later to manage in an environment that appreciates other values. Sufficient care allows the brain to develop a higher level of self-regulating skills, which eventually leads to the development of empathy and self-reflection and the expression of creative abilities. Any society reaps as it has sown with regard to the care it provides for its young (Perry, 1997; Teicher, 2002).

The human brain is unfinished at birth, and many of its capacities unfold only after birth. It is designed to survive in particular environments, cultures, languages, and climates, and the parents shape their child's brain in unique ways. In good cases, with good parents, early brain development equips the child with benefits for life. In bad cases, for example in the case of parental psychopathology, the brain is shaped in a way that causes the child to develop

maladaptive sides, which he or she will have to struggle with throughout life.

Cerebral development

The brain differs from most other organs by having a growth spurt that begins before birth and lasts until a few years after birth. One consequence of this timing is that in some regards the brain is most sensitive to both beneficial and harmful influences during this period. The brain's development process stretches over several overlapping phases. Its basic structure is formed during gestation, but its development is far from complete at birth.

Human infants are born with more neurons than they need. During childhood, about half of the unused neurons are eliminated (pruning), while the neurons that are frequently used and activated become part of specialized neural circuits and are strengthened (parcellation). Cell death serves to fine-tune function and appears to be associated with increased specialization of the functions managed by the various parts of the brain. The final stage of neural maturation, growth and differentiation, depends on stimulation.

Plasticity and vulnerability

Animal studies show that learning causes growth in synaptic connections and gene activation and, thus, genetic expression (Kandel, 2005). Thus, external stimulation shapes neural connectivity, and in the long term it builds experience that remains modifiable throughout the lifespan. The circuits are not only sensitive to the results of early experiences but are constantly affected and modified by new experiences. The external stimuli determine which connections are strengthened and which are pruned, and the neural pattern is constantly changing. Those connections that are activated most frequently are maintained and developed. This process enables the brain to adapt to its surroundings whether the person grew up in the tropical desert or in the Arctic.

Dysregulation that occurs during a particular critical phase for the development of neural circuits is not always evident until the symptoms emerge. For example, Varela and Maturana (1992) write

that if a newborn lamb is separated from its mother for a few hours and then reunited with her, the lamb will appear to develop normally until it begins to interact with other lambs. A lamb that had been separated from its mother does not know how to play, and it becomes isolated. This animal's reaction patterns and nervous system clearly differ from those of other lambs due to its brief separation from its mother, perhaps because the mother licks the newborn lamb incessantly during the first few hours after birth. Because it was separated from its mother, the newborn lamb was deprived of this tactile stimulation and, possibly, the release of certain neurotransmitters that would have been triggered by this interaction. The lamb's interaction with the mother immediately after birth appears to have substantial impact on the development of the nervous system, and the consequences are evident in the lamb's behaviour in areas that are far removed from the licking behaviour.

The magnificence of the nervous system lies in its plasticity in relation to the environment, and neural circuits can develop only when they receive optimum levels of arousal and stimulation. Both the nature and the timing of experiences are important for development. Children and parents reflect the world they have been born into, and the human brain has immense capacity for developing in a user-friendly manner. The brain grows, organizes, and functions in relation to unique life experiences, and experience modifies all human behaviour. But the complexity of the brain also makes it a vulnerable and fragile structure.

Environmental influences

At first, an infant's affectivity is regulated by others, but, through the process of early development, affects gradually become self-regulatory as a result of stimulation and neurophysiological development (Thompson, 1990). Animal studies show that a stimulating and enriched environment has a long-term effect on neurological structure and neurochemistry. Stimulation can physically enlarge, diminish, or alter the brain. Experiments with rats have shown that rats that grew up in an enriched, stimulating environment developed more brain mass than rats that were left in an empty cage without playmates or toys. When the deprived rats were moved to

stimulating settings their brains developed, but they never reached the same levels as the rats that had been exposed to the stimulating environment from the beginning. The researchers even found a hereditary effect that was passed on to the next generation. Gopnik, Meltzoff, and Kuhl (1999) describe how rat pups with parents that grew up in enriched environments are born with a thicker cortex than rats whose parents were deprived.

From nature to culture

Environmental influences on the stimulation of neurological growth is so robust that even malnourished rats that grow up in an enriched and stimulating environment have larger brain mass than well-fed but less stimulated rats (Cozolino, 2000). The brain regions that are used are the ones that develop, which is evident, for example, in active musicians who have a higher neuronal density in the brain areas that control the fine motor skills they use for their particular instrument. A study of London cab drivers found that the brain regions that enable the drivers to find their way are strengthened after six months of navigating the streets of London (Maguire et al., 2000). Understimulation causes apoptosis as well as a reduction in the number of neural circuits and their connectivity and branching. The growth in the number and complexity of circuit connections is the result of ongoing stimulation in a varied environment, which is probably the biological basis for all subsequent behavioural, emotional, motor, and cognitive development.

From an evolutionary point of view, the extended childhood is beneficial to humans. The long period of dependency is adapted to match creatures whose main speciality is the ability to learn (Gleitman, 1995). Human nature is culture, and culture is important in relation to the transfer of experience from one generation to the next. Humans are born to communicate and share ideas, and we depend on social exchanges. The infant enters this world and has to engage in human contact, adjust, and learn systems of meaning through constant interactions with the care-givers. Without this exchange, development runs awry, and the humanization process is stunted. Emotional and cognitive communication is a characteristic of our species.

In the USA in 1970, a thirteen-year-old girl was discovered who had been strapped into a chair most of her life and been deprived of sensory, emotional, motor, and language stimulation. In many regards she was retarded, and Russ Rymer wrote poetically about the development of the human brain:

> Brain maturation is not about the way the brain grows . . . It's about the way it dies. As it ages, its neurons disappear. As the brain sheds neurons, it sheds its plasticity, its blank potential. But at the same time the shape of its character and skills is revealed, the way a sculpture is revealed by the chipping away of stone. The process is known as stabilization. [Rymer, 1993, p. 169]

Summary

The discussion about nature *vs*. nurture seems never-ending, and the lack of a conclusion affects the views on maladaptive behaviour and personality disorders. In this chapter, I proposed a combined view of nature and nurture, where heredity (nature) and the environment (nurture) interact as inseparable aspects. Next, I discussed the triune, hierarchical brain, a model that I will continue to refer to in subsequent chapters. The evolution of the brain influences brain maturation and personality formation, and I have discussed the unfolding of the brain's plasticity against the background of the available environment. Our genetic make-up is important for the potential of the nervous system, and among the topics of the following chapter are the relationship between genotype and phenotype and the effect of gestation on the nervous system.