Neuroscience for the Society; the Power of the Individual Brain

Magdolna Szente

NEW TECHNIQUES IN TREATING NEUROLOGICAL DISORDERS AND MENTAL HEALTH

Up to even a few years ago, therapies to treat brain tumours, such as surgery, and irradiation, were only able to prolong the patient's life, but rarely provided a cure. However, slow, but promising progress and even some breakthroughs have marked the past ten years in this field of neuroscience (Rutka, et al., 2000). Molecular strategies, advanced cytogenetics, cell imaging, gene therapy, and stem cell utilization are examples of new techniques which are currently being either used or sought for brain tumours, stroke, neurodegenerative diseases, vascular malformations, spinal degenerative diseases, and congenital malformations of the central nervous system. With the images of the working brain by PET (*Positron Emission Tomography*) and fMRI (*functional Magnetic Resonance Imaging*), neuroscientists hope to be able not only to make more accurate diagnoses of brain disorders but also to better understand physiological functions and the way how people learn and think. These new, powerful techniques will lead to a deeper insight into pathological processes and to novel forms of therapy improving the patients' chances of life and health. Brain cancer patients might eventually found a reason of hope in the next decades (Weismar, 1999).

The outlook for treatment of multiple sclerosis has become more hopeful and a number of new antiepileptic drugs were also introduced in the 1990s. Moreover several drugs have shown early promise in preventing Alzheimer's disease or slowing its progression. Stem cell research within the past decade has caused tremendous excitement among neuroscientists because it gives us hope to restore someday brain cells lost in diseases as Parkinson's and Alzheimer's (Shamblott, 1998).

Once considered rather a moral, than a sociological problem, addiction is undergoing conceptual renovation and modification (Bolla et al., 1999; Nat. Inst. on Drug Abuse, 1998). Major progress has been made in understanding how drugs and alcohol affect brain and how they lead to addictive behaviour. Today, many scientists are gaining helpful insight into the roots and long-term effects of addiction by looking into the physiological basis of the disorder, using such tools as genetics and brain imaging. Using a new techniques for amplifying RNA extracted from post-mortem brain issue, the researchers are building the most detailed picture yet of gene dysregulation in the alcoholic brain.

GENETIC ADVANCES IN NEUROSCIENCE AND SOME CONCERNS

When the Human Genome Project is completed, in the foreseen year 2003, it will provide opportunities for neuroscience's most important scientific achievements of the 21st century. G*enetic advances in neuroscience* are already promising, including identification of genes that cause Huntington's disease, some forms of epilepsy, and rare forms of Alzheimer's disease, as well as genes of some forms of hearing and vision loss attested during the last decade. Moreover, in 1999, genetics researchers found a gene in brain that may someday make us smarter (Tang et al., 1999). However, we have to account cautiously this piece of information, since the integrity of many brain regions is required for proper performance of even the simplest memory task; probably there will be many other important genes discovered that affect learning and memory.

The process by which the brain is put together during development, are of great interest, not only to learn how and why we became what we are, but also because mistakes during brain development lead to several disorders such as mental retardation and epilepsy (Rakic, 1999; Penn et al., 1999). Epilepsy is a condition in which populations of neurons become hyperactive and begin to fire in a synchronous, rhythmic manner, we know as seizure. Studying the firing patterns of epileptic neurons has led many scientists to investigate structure of ion channels and offers drug researchers new opportunities for treatment strategies (Doyle et al., 1998; Westphal et al., 1999). Epilepsy may be caused by over 180 gene disorders known at present, but epilepsy gene map is continuously expanding. Chromosomal disorders can also cause epilepsy (Delgado-Escueta et al., 1999). Therefore it is unavoidable to examine the ethical and social acceptability of reducing the number of epilepsy genes in the human population. There is a general agreement that somatic and germ-line engineering and therapy can enrich and reshape society for the better. Efforts to extend somatic gene therapy to germ-line engineering will make it possible to harvest the benefits of the Human Genome Project and apply them to the fatal forms of epilepsy, focal cortical displasia and other neurodegenerative disorders. Some experts are speculating that cassettes of genes may prevent epilepsy caused by head trauma or birth injury. This issues, however, will challenge many souls. Would this be considered as eugenic genetic engineering or enhancement genetic engineering? Will the benefits outweigh the risks? If gene testing leads to populations being classified according to their genetic composition, serious ethical questions about equality and discrimination may arise. In any case, extensive study and experience in experimental animals must prepare the way for the application of these techniques on humans. Perhaps less explosive in social and ethical terms, but equally important is the discovery of dormant neural stem cells in the brains of children and adults.

Brain research will advance in the next future, addressing other problems, like development and reload in the brain, brain's circuits involved in depression, the role of the prefrontal cortex region in controlling attention, decision-making, and behaviour, what is most frequently impaired in *neuropsychiatric illnesses*. More effective treatment for mental illness will be the result of a better understanding of neurotransmitters, the inter-neuronal signalisation, and numerous genetic factors involved. The *neuroscience of mental health* – a term that includes studies extending from molecular events to psychological, behavioural, and societal phenomena – became one of the most exciting areas of scientific activity and therapeutic experimentations.

According to the World Health Organization's predictions, early in this new millennium psychiatric distress will be one of the worst strikes of Mankind with an enormous human cost. The aberrations of thought, emotion, and behaviour that characterise mental disorders such as manic-depressive illness, depression, schizophrenia, and addiction are burdening not only the afflicted individuals but also their family and friends. According to a report of US Surgeon General's office (1999), 1 out of 5 people suffers from some form of mental disorder in a single year. An estimated 6.5 million people (as many as 4 million are children) in the USA alone are disabled by severe mental illness, including major depression, schizophrenia, and anxiety disorders, and their future depends on the development of new therapies. More than 2.3 million Americans aged 18 and over - about 1 % of the population – suffer from manic-depressive illness; as many as 20 % of them die by suicide.

One of the problems in effectively treating mental disorders is properly diagnosing them (Drevest, 1998). Without knowing the causes of irrational or violent behaviour, people react with cynicism and fear rather than with compassion. Many people living in the defeating and hopeless atmosphere of mental disorder are still ashamed to seek help.

Within the past few years several genes have been found implicated in different forms of mental retardation with subtle learning impairments. Mental disorders are probably the product of the interactions between several genes that confer vulnerability to a given disease. Because these genes appear to play a highly specific role, they offer exciting targets for developing drugs to treat mental retardation. On the other hand, equally problematic is the identification of possible environmental "second hits", the non-genetic factors that convert a genetic susceptibility into full-blown illness.

It has became increasingly clear, that mental illnesses are expressions of disorders of brain states, even if they are genetically or environmentally determined. As the collective image of the human brain grows ever more clear, the stigma on so many people, suffering with mental illnesses because they are ashamed to ask for help, or because they do not think help is possible, may at least begin to fade (Delivering Results, 2000). Gradually, the public has come to recognise that mental disorders are the consequence of something gone wrong in a critical organ of the body: the brain.

Bipolar disorder (also known as manic-depressive illness) is a complex genetic disorder in which the core feature is pathological disturbance in mood, ranging from extreme euphoria, or mania, to severe depression usually accompanied by disturbances in thinking and behaviour. To date most genetic studies have been focused on neuro-transmitter systems influenced by medication used in clinical management of the disorder but with no positive proof that it may be treated chemically. It is however possible that genes involved in the genesis of this kind of psychotic illness will be identified in a few years. This will have a major impact on the understanding of pathophysiology of the disease and will provide important opportunities to investigate the interaction between genetic and environmental factors involved in pathogenesis. This is likely to lead to major improvements in treatment and patient care but will also raise important ethical issues that will need to be addressed (Craddock, 1999). Research on the prevalence of depression and manic-depressive illness among gifted artists, writers, and musicians, make scientists suspect that genes predisposing an individual to these illnesses might also confer a predisposition for creativity (MacKinnon et al., 1997). It is also shown that suicide rates among these people are well above those of the general population (Jamison, 1999). If this is the case, after unravel the genetic puzzle of mood disorders, will society take the risk of medicating away, or eliminating genes, which can result in changing personality or creativity also? Should high-risk individuals undergo genetic testing and gene manipulation? If there is relationship between certain kinds of psychopathology and artistic creativity, how should be artists who are affected with these pathologies treated? By eliminating the genetic roots of mood disorders in an effort to get society rid of this devastating illness, what else do we risk losing? May be a solution, that would be optimal for the individual, is not necessarily good for the society? Alternatively new therapies for mental illness, including new drugs and combination of drugs and talk therapy turned out to be useful for treating some of the most devastating illness of the mind.

Although *advances in neuromodulation techniques* promise new therapeutic interventions for patients with neuropsychiatric illness, several complex social, and ethical issues will accompany developments in this field. For example, approximately 10 % of all US boys between eight and thirteen are currently treated by potentially hazardous amphetamine-like drug (Ritalin) to treat their "attention deficit hyperactivity disorder" due to some fault in their genetic make-up. There is no doubt that treating children with such a drug will affect their behaviour. However, being inattentive or disobedient may have many other causes, from poor school teaching or home abuse, poor social conditions, and so on. The technological thrust to generate a psycho civilized society by brain manipulation, from psychosurgery to tailored drugs, is thus very strong (S. Rose, 1999). The misuse of some scientific results, the mechanistic approach to the neurochemical and biochemical observations of brain mechanisms may result in inadequate treatment of some patients. The reductionists use the potential of psychopharmacology to adjust our minds to suit the world. Moreover, psychopharmacology not only offers to adjust those who fit poorly into society, but also offers to improve already well adjusted individuals. The power of the so-called smart drugs make us to turn our attention inwards, away from worrying about the complex problems of the society in which we live, and towards our own selves, and to adjust our mind with drugs, in the search for personal happiness (S. Rose, 1999). Nevertheless it is important to keep in mind the words that Huxley put in his book, the *Brave New World*: "Hug me till you drug me honey, Love's as good as soma".

At present, there is a change in the way science understands mental health. However, psychiatric problems are not always understood in terms of the social environment, or the family, or even in a psychological field. It is argued that genetic bases of some familial traits are in specific variations in genes controlling neurotransmitters. On one hand, according to *psychopharmacology* everything is somehow 'passed through' the brain and its chemistry. On the other hand, *behavioural genetic* research, the other key determinant of the new psychiatry, reflects the fact that psychiatric conditions can present itself again in families. Both psychopharmacology and behavioural genetic research give explanation for psychiatric symptoms or conditions only in terms of brain biology. To go far into either of this direction would cause a fundamental shift in how we are thinking not just about psychiatric pathology, but about normal variations in human behaviour as well. The degree to which behaviour is inherited or acquired, influenced by closer or wider social and cultural environment, living conditions, free or predetermined by the genetic code is an issue that has to be considered.

Science is moving so fast, that the moral considerations are sometime in delay, and the true ethical dimensions are missing from our everyday practical decisions. If we really want to understand the social and ethical effect of new technologies in brain research, we have to acknowledge that some-thing new and rather complicated is going on in science. Science is part of the social representation, its social implication are deeply involved in the decisions and calculations researchers and clinicians have to make in their work (N. Rose, 2000). As genomic technology is applied in the pharmaceutical industry, the predictive testing, risk assessment, preventive products, development and marketing have more impact on our everyday life. "The hope, is that in addressing these development, from a social science perspective but at detailed and empirical level, we will illuminate in a new way the issues that must be addressed by those wishing to regulate these matters – whether that is by legal mechanisms, professional self-regulation or ethical guidelines" says N. Rose (2000).

The last decade of the 20th century has seen the development of neuroscience effectively integrating cognitive psychology, functional neuroimaging, and behavioural neurology as an effort to understand how the brain represents cognitive, mental events. Recently neurobiologists in cognitive neuroscience with increasing frequency turned to experimental psychology for guidance, inspiration and tools. This interdisciplinary collaboration resulted in discovery of some correspondence between neuronal and perceptual events, the role of context in perceptual processing, the neuronal substrates of attention and decision making, the plasticity of adult sensory representation (Albright et al., 2000). This new work is typically conducting basic research into aspects of the human mind and brain. Only in the past decade have neuroimaging studies demonstrated a pervasive form of localization of cognitive and mental tasks (Cebeza and Nyberg, 2000). Knowing recent results of cognitive neuroscience and human brain mapping, it is hard to imagine that there could ever have been doubts on the exsistence of specific anatomy related to higher mental processes. Nevertheless, none of the non-invasive methods can substitute for experimentation with living brain tissue.

FOR THE FUTURE

Imaging has strengthened the correspondence between the brain anatomy of human and that of experimental animals. Experimental neuroscience can make an enormous contribution to understand the brain's function. Using new techniques recently developed, it is possible to apply delicate electrical stimuli, or extirpate some specific anatomical sites in the brain, or develop new ways to explore neurophysiology on experimental animals like cat, rats or monkeys, which might let us form new speculations.

Progress in all of these areas is impressive, but much needs to be done to reveal the mechanisms of cognition at the local circuit and molecular levels. This work will require new methods for controlling gene expression in higher animals and studying the interactions between neurons at multiple levels (Milner et al., 1998). We have every reason to expect that the next decade will yield a molecular biology of cognition, in which molecular and genetic tools will serve cognitive neuroscience, and that the field will continue to advance through a global circuit-based approach to cognitive representation of the brain (Albright et al., 2000). Although as was emphasized by Hebb (1949) a pioneer in cognitive neural science whose thought is valid even today, there "still is a long way to go before we can speak of understanding the principles of behaviour to the degree that we understand the principles of chemical reaction"

Epidemiological evidence suggests that *psycho-social stress* may increase one's vulnerability to disease. Although, Selye himself (1936), who pioneered the study of stress, said "stress is not even necessarily bad for you, it is also the spice of life, for any emotion, any activity cause stress". However, chronic stress can not only increase the chance for illness but can also cause damage in parts of the brain that are associated with memory and cognitive abilities. Modern life leads many people to sustain tremendous stress.

Now the picture is becoming clearer as evidence reveals the connections between the brain, the stress response, and the immune system. In the last few years numerous medical centres established brain-body type therapies, such as meditation to reduce stress, and suggest understanding how the links between the brain and the body cause disease. Supportive family and social environment can enhance immune response, including resistance to such diseases as cancer, by reducing stress hormone levels.

Further research should be carried out to disclose the biological mechanisms that result from the stresses and nervous tension of living at lower end of socio-economic scale (McEwen, 1998). The questions in these fields are: do people with less money feel that they have less control over their lives? Do people with limited resources suffer worse health, because their everyday lives are more stressful? The toll of the stress on the individual is obviously high, but stress also takes an economical toll on society.

Our mental well being and physical well being are inseparable. The economic costs of brain dysfunction are enormous, but they pale in comparison with the staggering emotional toll on victims and their families. The pace of neuroscience research today is truly breathtaking, and raises hopes that soon we will have new treatments for the wide range of nervous system disorders that debilitate and break down millions of people annually.

THE POWER OF THE INDIVIDUAL BRAIN

"Men ought to know that from nothing else but the brain come joys, delights, laughter and sport, and sorrows, griefs, despondency, and lamentations. And by this, in an especial manner, we acquire wisdom and knowledge…. And by the same organ we became mad and delirious, and fears and terrors assail us…. All these things we endure from the brain when it is

not healthy…. In this ways I am of the opinion that the brain exercise the greatest power in the man." Hippocrates, On the Sacred Disease (Fourth century B.C)

Despite the considerable progress, neuroscientists still are facing big challenges to gain knowledge about brain higher functions like consciousness, cognition, and the relationship between brain and behaviour. Human beings have always wondered about the self, the consciousness we identify as ours, which resides in the body, and experiences the outside world. Understanding the mechanisms by which consciousness is developed helps us to better handle mental illness, and it will also make easier to explain our nature as human beings.

In spite of the recent achievements of the different philosophical and natural scientific sciences, and progress in understanding higher brain functions, at present a generally accepted, complete, unified theory on human brain function itself in broad terms has not yet been proposed (Helpern and O'Conel, 2000).

The problem of consciousness is one of the most exciting questions in science today. Consciousness has been seen as both a mystery and a source of mystery. Over the past decade or so, the relationship between consciousness studies and neuroscience positively changed. The issue of consciousness lies beyond neuroscience, or even psychology and philosophy, and only recently it has been considered a scientific object that is worthy of experimental investigation.

Since science is by definition objective, the scientific explanation of consciousness could only deal with the "objective" manifestation of consciousness and accept physical properties of the brain (Edelman, 2000). But at the same time it must take into account the "subjective" features of consciousness. The subjective indications of consciousness have the evolutional status of social existence that can be realised through communications among brains. In this sense they go beyond the functions that individual isolated brains would be capable of realising, therefore purely neurobiological explanations are not enough. This is why there were strong barriers to study this problem as a normal scientific one.

Descartes was the first great thinker who was struck by the curiosity of inner world, the strange speciality of the subjective viewpoint; he divided mind from body creating the roots for dualism. More recently, a materialistic position have been introduced claiming that mind and consciousness are identical to the function of the brain. In the past several decades, advances in neuroscience have renewed and clarified the integration of the brain and the mind. "Mind is what the brain does". The higher neuronal centres of mind and consciousness in the neocortex are the most recent evolutionary developments, occurring during the psychosocial phase. Their capacity for cognition, subjective emotional experience, creative actions, decision-making, exercise of judgement and will, determine and guide most of man's activities (Davidson, 2001).

However, it is a mistake to think that specifying particular locations in the brain or understanding intrinsic properties of any particular neurones, will in itself explain why they contribute to conscious experience. The postulated mechanism integrated within the brain has extensive connections with the neocortex, the limbic system, and through the hypothalamo-hypophyseal structure with the endocrine system. There are links also to the somatic nervous system, as well as the autonomous nervous system and through the hypothalamus to the immune system. The forebrain is partially functioning like a storehouse for imprinted symbolism for security elements, coded models of behaviour, which reflect man's interaction with environment. In fact, many different brain regions play parallel roles in brain and mind functions, analysing the outside world in different ways and reintegrating it to generate an associated whole.

Greenfield, the pharmacologist, emphasizes that there is not a magic ingredient in the brain that mediates consciousness; a critical factor could be the number of neurons that are activated at any one time and it is the extent of these assemblies that will determine consciousness. Greenfield describes consciousness as multiple, however effectively single at any one time. "It is an emergent property of non-specialized groups of neurons that are continuously variable with respect to an epicentre" (Greenfield, 1998). Furthermore, it is important to concentrate on the processes, not just the brain areas, that support consciousness, and more specifically to focus on those neural processes that can actually account for the most fundamental properties of consciousness (Edelman and Tononi, 1999).

Moreover, one of the ways to understand the functioning of the brain as a system, and the peculiarity of consciousness, is to learn how the diverse functions of the different parts of the brain are combined together to produce our own individual unitary sense of personhood, thought and experience (S. Rose, 1998). What we know from science is that all of the *conscious states* that we experience, are in fact *caused by neuronal processes* in the brain; in other words conscious experience is not separate from the brain. Even on the base of the statement that consciousness arises within the system of certain organisms it is assumed that consciousness can not be completely considered in its entire range as arising exclusively in the brain. Higher brain functions require interactions both with the world and with other persons (Edelman and Tononi, 2000). Several other leading neuroscientists underline that *consciousness is fundamentally a social phenomenon*, not the property of an individual brain or mind; the different modality of perception is the modification of a pre-existing field of consciousness (Llinas, 1998; S. Rose, 1998; Singer 1998)..

The brain is not a closed, rigid system, but it is in a continuous, multiple interaction with its environment (S. Rose, 1998). For humans, the environment is both the immediate *present* represented by the society, in which we are living, and the *past*, in our individual and social histories.

Marx formulated a similar idea in the nineteenth century, in accordance with the proposition of the neuroscientist Singer (1998). Singer says: "Those aspects of consciousness that give rise to the so called hard problems in the philosophy of consciousness, the experience of self-awareness and notion of the privacy of one's subjective sensations, transacted the reach of reductionistic neurobiological explanations, because these aspects are social phenomena and products of cultural evolution. Self-awareness and notion of the privacy of one's subjective sensations, consciousness belong to our world, but because they have a social or cultural origin, and hence both a historical and interpersonal dimension, they can not be understood simply as an emergent property of an isolated brain, and therefore they transcend the research of conventional neurobiological approaches"

While consciousness and self-awareness arise from neuronal activity of an individual brain, the dimensions occurring within these functions exceed the limits of an isolated brain and presume social and historical scope. But how much we depend on the inherited genes, to what degree we are the product of the social and family circumstances in which we grew up, and how much can we act within our own control and how we function as a society?

Of course we all like to believe in free will, but most of us at some point of our life want to know who we are and to understand how we come by our identity and why we feel and behave the way we do.

In recent decades the scientific discipline of *socio-biology* has been developed, which Wilson (1981) describes as "the systematic study of the biological basis of all forms of social behaviour, in all kinds of organisms, including humans". This area of science is the result of a great advance during the last two decades in ethiology, ecology, neuroscience and genetics. Wilson consider each living beings "as an evolutionary experiment, a product of millions of years of interaction between genes and environment; the brain exists because it promotes the survival and multiplication of genes that directs it assembly; in order to search for a new morality based upon a more truthful definition of man, it is necessary to look inward, to dissect the machinery of the mind and to retrace its evolutionary history". Wilson has been blamed of being a scientific fanatic who carried materialism too far. The strongest opposition to his scientific study of human nature has come from a small number of Marxist biologists and anthropologists.

It is equally impossible to separate the influences of the genes and the environment on the mind and the consciousness, although supporters of both sides often tried to do so. Galton in the nineteenth century argued for the dominance of genetic inheritance. Hitler took his eugenic idea to its horrifying conclusion in the mid-twentieth century. The dogmatic conclusions of genetic determinism are strongly controversial and dangerous. On the other hand, those who argue for the primacy of environment declare that family and societal influences are fundamental for everything from the general intelligence to mental stability.

Many patterns of behaviour are at least partially genetically determined, or inherent. On the other hand, some forms of behaviour are the results of conditioning, through education training and life experience. Any predisposition influenced by our genetic materials are far from being a life sentence. Even though research suggests that inherited neurochemistry bias young children to react in specific ways, the child's interactions with family, teachers and social environment can shape that predisposition considerably.

The disturbances in the chemical balance in the individual brain can trigger mood and behaviour disorders and mental illness. One of people's judgment on antisocial personality disorder is that they lack a conscience. The fronto-temporal dementia, for example, is a progressive degeneration of the brain, which is in its early stages, can cause aggressive or antisocial behaviour. Huntington's disease is an other inherited neurological disorder that can cause violent behaviour and emotional disturbance.

Many factors influence patterns of behaviour, some biological, some cultural. In the brain of most human beings there is symbolism or psycho-neurologic image of a supreme confidence figure – be it god, the state, Marx-Lenin, Mao, or the Sun-Emperor (Stevens, 1982). The reason for this variety is as much a mystery as the nature of the biologic symbolism itself.

As we learn more details about the genome, the influence of the early environment and of the chemical and physical state of the brain on our actions and behaviours, how can we make sure assertions in critical cases? How we might function and take steps both as a society and as human being, if we understand that our behaviour is genetically and/or historically determined to certain degree? The answers for these questions depend not only on our relationships with family and friends but also have implications on how we function as society.

In general, humans do have some competence in working out judgements and free will, they do not simply make reflex, pre-set decisions. In most instances humans have at least some control in making ethical decisions. Biology is not necessarily destiny (Kagan, 1999). Parents, society and we ourselves have the capability of shaping the way we react to what life bring to us. During evolution the human brain has developed to a sophisticated level, acquired the capability of making conscious decision and carry out different activities not only for survival goals, but also for improving individual and societal well being. In the interaction with environment during the psychosocial phase, the human is both the creator and the product of his culture, such as history, custom, religion and tradition (Helpern and O'Conel, 2000).

The basic characteristic of human consciousness and identity is that they are produced and modified by a brain that is continually learning and unlearning, storing experience, become accustomed to the world around us.

Today it still remain the challenge and paradox of the highly sophisticated biological apparatus, the human brain – that is responsible for human's cultural history and scientific achievements - to develop definite means to reach either individual or global security. Perhaps this could be partially explained by the mutual respect of the biological territoriality on the part of the "superpowers", an awareness of the self-delusional nature of motivation, and the unconscious working of the security circuit of the human brain (Helpern and O'Conel, 2000).

KEYWORDS Neurobiology. Mental Health. Human Genome Project.

ABSTRACT Within the past few years several genes have been indentified that confer vulnerability to a given neurological disease. Somatic and germ-line engineering an therapy can enrich and reshape society for the better, these issues however will challenge many souls. Would this be considered eugenic genetic engineering or enhancement genetic engineering? Will the benefits outweigh the risks? Although advances in neuromodulation techniques offer new therapeutic interventions for patients with neuropsychiatric diseases, several complex social and, ethical issues will accompany developments in this field. The misuse of some scientific results, the mechanistic approach to the neurochemical and biochemical observations of brain mechanisms may results in inadequate treatment of some patients. The society must face the question: at what point does behaviour become abnormal, and who has the right to decide what is abnormal? As we understand more about the brain, will alter the socity's views on the moral and legal responsibilities of individuals? During evolution the human brain has developed to a sophisticated level, acquired the capability of making conscious decision and carry out different activities not only for survival goals, but also improving individual and societal well being.

REFERENCES

Albright, T. D., Kandel, E.R. and Posner, M.I.: Cognitive neuroscience. *Current opinion in Neurobiology,* **10:** 612-624 (2000).

Bolla, K., Rothman, R. and Cadet, J.L.: Dose-related neurobehavioral effects of chronic cocaine use. *J. of Neuropsychiatry and Clinical Neurosciences,* **1:** 361-369 (1999).

Craddock, N, and Jones, I.: Genetics of bipolar disorder. *J. Med. Genet,* **36:** 585-94 (1999).

Cebeda, R. and Nyberg, L.: Imaging cognition. II: an empirical analysis of 275 PET and fMRI studies. *J. Cog. Neurosciences,* **12:** 1-47 (2000).

Davidson R.J.: Toward a biology of personality and emotion. *Ann. N. Y. Acad. Sci.,* **935:** 191-207 (2001).

Delgado-Escueta, A.D., Olsen, R.W., Wilson, W.A. and Porter, R.: Introduction to idiopathic epilepsies. In: *Jasper's Basic Mechanisms of the Epilepsies,* Third edition: *Advances in Neurology,* Vol. 79. Pp. 219-238. A.V. Delgado-Escueta, W.A. Wilson, R.W. Olsen and R.J. Porter. (Eds.). Lipponcott Williams and Wilkins, Phyladelphia (1999).

Delivering Results: A progress report on brain research, Terri Rutter, (Ed). The Dana Press, Washington D.C. (2000).

Doyle, D. et al.: The structure of the potassium channel: Molecular basis of K^+ conduction and selectivity. *Science,* **280:** 69-77 (1998).

Drevest, W.C.: Functional neuroimaging studies of depression: The anatomy of melancholia. *Annual Review of Medicine,* **49:** 341-361 (1998).

Edelman, G.M. and Tononi, G.: *Consciousness. How matter becomes imagination*. Allen Line, The Penguin Press (2000).

Greenfield, S.: How might brain generate consciousness? In: *From Brains to consciousness?* S. Rose, (Ed.). Clays Ltd., St Ives plc., pp:210-227 (1998).

Halpern, G.J. and O'Connel B.E.: The security circuits: A proposed construct for the central nervous system. *International J. of Neuroscience,* **102:** 1-254 (2000).

Halpern, J.C. and O'Connell, B., E., The security circuit: a proposed construct for the central nervius system. *Intern. J.*

Neuroscience, **102:** 1-254 (2000).
Hebb, D.: *The Organization of Behaviour: A Neuropsychological Theory.* Wiley, New York. (1949).
Jamison, K.R.: A magical range grove; In a nightmare: Creativity and mood disorders. In: *States of Mind.* R. Conlan (Ed.). John Willey and Sons, Inc., N.Y., pp: 53-79 (1999).
Kagan, J.: Born to be shy? In: *States of Mind.* R. Conlan (Ed.). John Willey and Sons, Inc., N.Y., pp: 29-51 (1999).
Llinás, R. Ribary, U., Contreras, D. and Pedroarena C.: The neuronal basis for consciousness. *Philos. Trans. R. Soc. Lond. B. Biol. Sci.,* **353:** 1841-9 (1998).
MacKinnon, D.F., Jamison, K.R. and DePaulo, J. R.: Genetics of Manic-depressive illness. *Annual Review of Neuroscience,* **20:** 355-373 (1997).
McEwen, B.S.: Protective and damaging effects of stress mediators. *The New England J. of Medicine,* **338:** 171-179 (1998).
Milner, B. Square, L.R. and Kandel, E.: Cognitive neuroscience and the study of memory. *Neuron,* **3:** 3445-3468 (1998).
National Institute on Drug Abuse, NIH Publication Number 98-432 (1998).
Penn, A.A. and Shatz, C.: Brain waves and brain wiring. The role of endogenous and sensory-driven neural activity in development. *Pediatric Research,* **45 pt. 1:** 447-458 (1999).
Rakic, P.: Principles of neuronal cell migration. *Experientia,* **46:** 882-891 (1999).
Rose, S.: *From Brain to Consciousness?* Clays Ltd., St Ives plc. (1998).
Rose, N.: Listening more closely, to Prozac. *Welcome News,* **25:** 22-23 (2000).
Rutka J.T. Taylor M. Mainprize T. Langlois A. Ivanchuk S. Mondal S. and Dirks P.: Molecular biology and neurosurgery in the third millennium. *Neurosurgery,* **46:** 1034-51 (2000).
Selye, H.: A syndrome produced by diverse nocuous agents. *Nature,* **138:** 32 (1936).
Shamblott, M.J.: Derivation of pluripotent stem cells from cultured human primordial germ cells. *Proceedings of the National Academy of Sciences,* **95:** 13726-31 (1998).
Singer, W.: Consciousness from a neurobiological perspective, In: From Brains to consciousness? S. Rose (Ed.) Clays Ltd, St Ives plc. pp:228-245 (1998).
Stevens, A.: *Archetypes, a Natural History of the Self.* William Morrow and Co., Inc. New York (1985).
Tang, Y. P., Shimizu, E., Tsien, J. et al.: Genetic enhancement of learning and memory in mice. *Nature,* **401:** 63-69 (1999).
Weismar, R.: When the brain goes wrong. MGH Summer (1999).
Westphal, R. et al.: Regulation of NMDA receptors by an Associated phosphatase-kinase signalling complex. *Science,* **285:** 93-96 (1999).
Wilson, E.O.: *On Human Nature*. Cambridge, The Belknap Press of Harvard University Press, (1981).

Author's Address: **Prof. Magdolna Szente,** Depertement Comparative Physiology, University of Szeged, Kozepfavor 52, 6726 Szeged, HUNGARY
E-mail: szente@bio.u-szeged.hu

Human Ecology Special Issue No. **12:** 69-76 (2004)
Societal Responsibilities in Life Sciences
Charles Susanne, *Guest Editor*