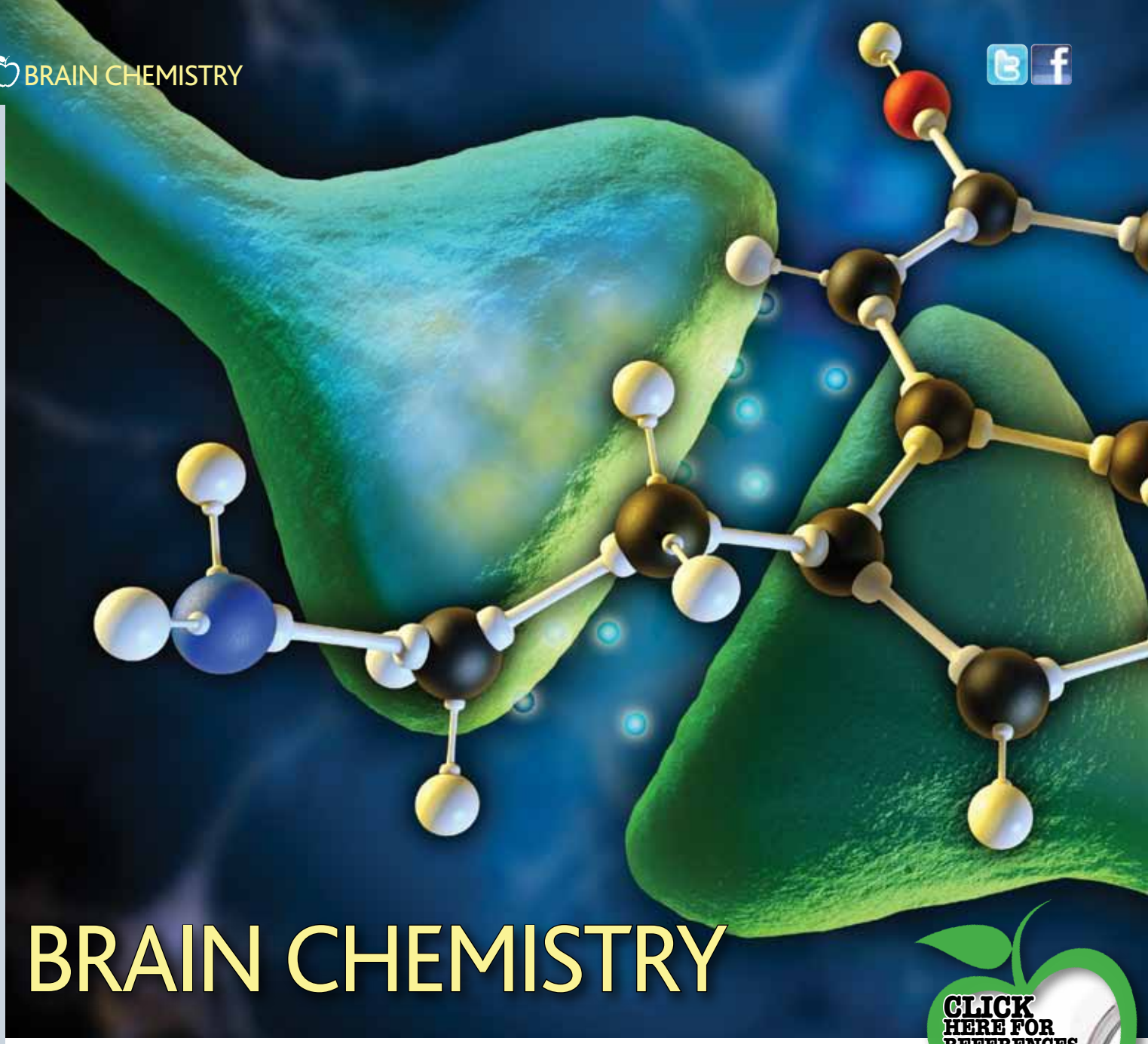

BRAIN CHEMISTRY

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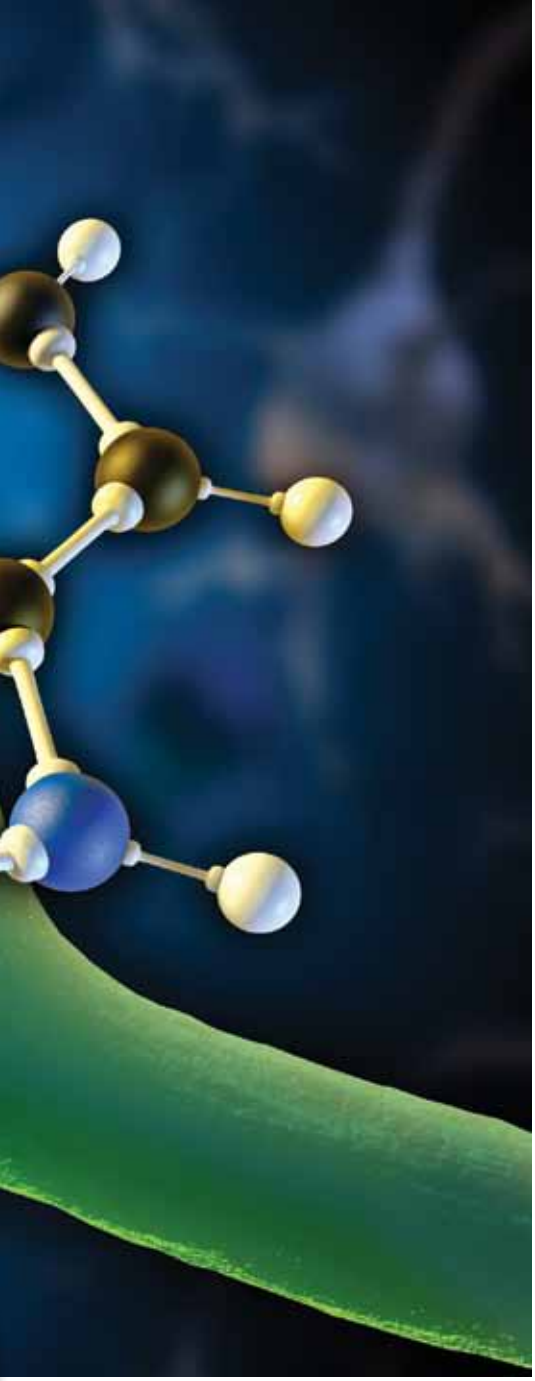
The more we discover about brain chemistry, the more redundant the term 'psychosomatic' becomes. ***Fleur Borrelli*** *explains why we can no longer make a distinction between 'the psyche' and the 'soma'...*

The brain is the master controller of the body. Every sensation produced by the brain is in response to our environment. It regulates homeostasis and how we interpret danger. The capacity to think both in the present and also to plan for the future is provided for and we are able to experience pleasure and reward but also pain.

Encased within a protective barrier separating it from the circulatory system, it is vital that the brain should function optimally. But according to the United States Department of Health and Human Sciences (HHS), neuropsychiatric disorders account for 36 per cent of all non-communicable conditions globally. Of these neuropsychiatric disorders, depression causes 40 per cent[1]. So what is going wrong?

Humans have the largest brains of all mammals compared to body size. The body's communication system, the Autonomic Nervous System (ANS), begins with the central nervous system located in the brain and the spinal cord. Sensory nerves gather information from the environment for the brain and motor neurones to deliver instructions to the rest of the body. The brain stem at the base of the brain maintains vital functions such as breathing, digestion and swallowing. Alongside this, the brain ensures homeostatic balance with the aid of the midbrain. If homeostatic balance cannot be recovered quickly enough we may feel hunger, thirst, cold, heat or pain, which will encourage a spontaneous movement. A decision can then be made by the neocortex to restore calm.



MIDBRAIN - MEMORY, REWARD, PLEASURE, PAIN

Decision-making is a process in which all parts of the central nervous system are used, with the right decision providing rest in these allostatic systems. The hypothalamus and pituitary gland in the midbrain perform neuro-endocrinological functions to maintain allostatic balance. Within the midbrain and the brain's stem there is the 'reward circuit', that incites the production of pleasure and satisfaction- inducing substances, endorphins, oxytocin and dopamine[2]. The neocortex, due to its 'memory', allows for information storage and learning and for this reason has been compared to a computer.

When there is a homeostatic disturbance, we rely on our allostatic systems to restore equilibrium once more. Allostatic survival mechanisms are alerted if we sense danger. The first is the sympathetic nervous system – adrenal medulla axis (SAM), which is necessary for the fight-or-flight response and then a little later the Hypothalamus-pituitary-adrenal gland axis (HPA)[3]. Between them they prepare us for action by mobilising energy resources and informing the immune system. No distinction is made by these systems between a deadly virus, a macronutrient deficiency, a micronutrient deficiency or the constant worry of a mortgage that needs to be paid. An external temperature change, an energy deficiency or emotional problems can all activate our stress systems. If homeostasis is restored in time our body temperature, blood pressure, osmotic pressure, glucose levels, pH values and energy distribution all remain stable.

A recent study in the journal *Nutrition and Metabolism* suggests that a delay in recovery however, might give rise to damage and long-term activation of the innate immune system leading to chronic systemic inflammation or the low-grade inflammation process[4].

LEFT HEMISPHERE - DECISION-MAKING IN THE FUTURE

Adaptogenic capacity is a person's capacity to adjust to a particular time and place. Thinking about the future and making plans seems to have been a relatively recent characteristic of brain function and may have corresponded with the development of language[5]. Evidence of 'thinking in terms of the future' can be demonstrated by signs of food storage and seems to have been based on the increased intake of foods containing iodine, such as shellfish[6]. Iodine is required for the development of the brain and for dopaminergic neuro-anatomy. Dopaminergic neuro-anatomy involves mainly the left hemisphere, which has been associated with decision-making in the future[7]. Disorders such as autism, ADHD, schizophrenia and obsessive compulsive disorder have been connected with hypothyroidism in the mother, including a lack of iodine[8].

RIGHT HEMISPHERE - HERE-AND-NOW

Functions related to the present, the 'here-and-now', are mainly performed by the right hemisphere. This is chiefly controlled by serotonin and noradrenaline and is a very energy consuming process[9]. These include consuming food, caring for children and registration of and reaction to danger. The right hemisphere may therefore be linked more to the sympathetic nervous system which is required for the restoration of homeostasis, Here-And-Now (HAN), and is regulated by the release of serotonin by the raphe nuclei.

GOING "OFFLINE"

Today's society is full of information, economic pressure and future-decision making that may require dopaminergic 'offline', 'There-And-Then' (TAT) behaviour. People who cannot 'go offline' may be more vulnerable to the conflict between their 'serotonergic identity' and the dopaminergic environment. A recent study published in the journal *Metabolism* highlights the prevalence of HAN domination in people who were abused and/or neglected in the first eighteen years of life[10]. Examples of serotonergic exhaustion are fibromyalgia, chronic fatigue, depression and low grade inflammation illnesses.

DOPAMINE FOCUS

Dopaminergic neuro-anatomical development teaches an individual to postpone rewards and make the right decisions. But, according to a report published in *Pediatrics In Review*, this depends on how they have been nurtured as a child. If their needs have constantly been denied, it may cause a state of disassociation[11]. Disassociation is also known as a dorsal vagal 'freeze' reaction designed to conserve energy. With repeated dissociative moments, disengagement of the parents by the child can occur and increased sensitivity of the stress systems. This may have a dramatic effect on the future adult[12].

Chronic activation of the seeking system could increase nerve connections between these limbic parts of the brain, causing a reduced connection to the frontal lobes. The dopamine-sensitive neurons in the frontal cortex should normally inhibit seeking for direct reward

in the adult brain[13]. They allow you to be able to make the right choice of buying some water because you are thirsty rather than grabbing a beer.

Normal development of dopaminergic connections to the frontal lobe may also be influenced by intra-uterine and prenatal dietary factors. While there are only animal studies available, it is likely that these connections depend on an adequate supply of omega-3 fatty acids, especially DHA, iodine and l-tyrosine and vitamin D.

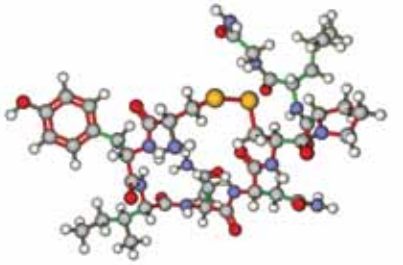
Dopaminergic neuro-anatomy may therefore be responsible for motivational behaviour, drive, seeking behaviour, addiction and reward sensitivity. Dark chocolate with 60-80 per cent cacao, has been shown in *in-vitro* studies to have a dopamine-like euphoric effect.

METABOLIC FLEXIBILITY

Psychological health is associated with being able to be flexible. That is, to be able to move comfortably between a dopaminergic or a serotonergic phenotype when the situation demands. The dopamine drive is important to successfully manage a professional life. It makes you fast, visually capable and goal-oriented. Workaholics may remain healthy if they are motivated by what they do, but stepping over the limits of this system could result in paranoia, aggressiveness, addiction, obsession, an unstoppable drive and even insanity. Their optimal effectiveness, according to a report published in *Clinical Psychology Review*, depends on the development of the left and right frontal lobes[14]. They link this to metabolic flexibility or the capacity to be able to change energy sources accordingly. The right 'serotonergic' hemisphere may be responsible for increased use of glucose as an energy source while the left induces the capacity to burn fat. Factors that may affect this 'cross-talk' between the two systems have been put down to epigenetic programming, early life experiences and chronic stress[15]. A combination of adaptogens such as hypericum, gingko biloba, ginseng, rhodiola and curcumin may offer a basis for the recovery of the capacity to switch between the two systems[16].

DOPAMINE DEFICIENCY

Parkinson's disease is an example of dopamine deficiency. Typical Parkinson's symptoms are emotional disorder, lack of initiative, rigidity and the so called On-Off syndrome. The On-Off syndrome is characterised by either not being able to start moving (On) or not being able to stop (Off). People who suffer from Parkinson's may be treated with synthetic L-dopa which paradoxically seems to be neurotoxic, especially for neurons in the dopamine-producing areas[17]. In animal models of Parkinson's disease, *Mucuna pruriens*, which contains the active ingredients Nicotinamide Adenine Dinucleotide (NADH) and Co Enzyme Q10, has been shown to have neuroprotective effects. CoQ10 may be a promising intervention for people with neurodegenerative disorders such as Parkinson's, but also Alzheimer's and Multiple Sclerosis[18]. A whole new approach for Parkinson's and other neurodegenerative syndromes is the use of hyper physiological amounts of thyroid gland hormone[19]. This may lend weight to the possibilities of iodine, l-tyrosine and selenium as natural alternatives.



SEROTONIN FOCUS

Neurodegenerative disorders appear to be increasing at an alarming rate. According to NHS 2012 statistics, anti-depressant prescriptions in the UK jumped by 9.6 per cent in 2011 to 46 million prescriptions[20]. The majority of anti-depressive medication acts on serotonin signalling. One of the main functions of serotonin is the activation of neurons within the hypothalamus that are responsible for the production of oxytocin[21]. While serotonin deficiency may well be present in depression, success rates with antidepressants appear to be low with the possibility of up to 60 per cent of patients being treatment-resistant[22].

One explanation given is because of the dramatic changes of lifestyle in Western humanity in terms of diet and exercise. The shift from proteins and fat as important nutrients to refined carbohydrates in particular may underlie disorders in nutrient-gene interactions[23]. This refers to disorders in genes that function physiologically within a traditional genetic environment encouraging illness – pathologies such as Parkinson's, Alzheimer's and schizophrenia may be the consequence. Support may lie in a diet with a high intake of proteins and omega-3 fatty acids[24], vitamin D, vitamin A and iodine as well as intermittent fasting[25].

Serotonin, formed from L-tryptophan, relies on a regular supply of tryptophan-containing foods such as chicken, turkey, soybeans and tuna coming in from the diet. Folic acid is necessary for the conversion of tryptophan to 5-hydroxytryptophan. Another promising intervention is *Crocus sativus* from which saffron is produced. Its active ingredients may have a unique influence on multiple pathways related to diseases such as Alzheimer's, dementia, sexual disorders, depression, anxiety and pain[26][27].

Alongside ensuring an adequate intake of nutrients and reducing stress, is the importance of recovering a natural biorhythm. Neuro-degeneration may occur due to a disruption in the genetic environment through eating the wrong foods, lack of exercise and inadequate sleep. However neurogenesis can be encouraged by physical exercise, intermittent fasting, brain jogging and maintaining a natural curiosity or motivation for life. ●

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