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Book reviews

How Brains Make up Their Minds. By W. J. Freeman. (Pp. 180; £14.99.) Weidenfeld & Nicolson: London. 1999.

In neuroscience today two very different concepts exist of how the brain operates as a whole. In the first, or classical model, the brain is described as consisting of a series of causal chains composed of nerve nets that operate in parallel. These are organized in a hierarchy that processes information using linear dynamics, summing junctions, logical gates and matrix multiplication. Memories are stored banks and are read out like the content-addressed memories of computers. The electric rhythms recorded by the EEG are regarded as mere volume summations of all this atomized activity. Recently, this model has divided into two subsections – the connectionist (in which synapses are more or less permanent and computation is effected by changing synaptic weights) and the constructionist (in which synapses are dynamic structures and computation is effected in part by growing new synapses and removing old ones).

The alternative, which Freeman presents in this book, he calls the pragmatist or neurodynamic model. In this, the brain operates by non-linear dynamic chaos – as Freeman says in a telling phrase '… brains are drenched in chaos'. The neurons in the brain form dense networks. The balance of excitation and inhibition allow them to have intrinsic oscillatory activity and overall amplitude modulation (AM). Freeman's extensive experiments on the EEG of the olfactory bulb shown that these AM patterns are expressions, not merely of summated linear dendritic and action potentials, but of non-linear chaos. These AM patterns work by creating attractor basins and attractor landscapes. In the classical model neurocomputation is effected by a myriad of parallel microprocessors all doing their own analysis of different aspects of the information inflow. Their results are passed on to other microprocessors higher in the hierarchy inflow and finally to the motor system. In the neurodynamic model, in contrast, every neuron participates, to some extent, in every experience and every behaviour, via non-linear chaotic mechanisms. Moreover, the same perception, or same behaviour, can be effected at different times by different subsets of neurons within the major dynamic group.

'The formation of global AM patterns indicates that the sensorimotor and limbic areas of each hemisphere can rapidly enter into a cooperative state, which persists for perhaps a tenth of a second before dissolving to make way for the next state… . The true picture is that the global activity of the brain has regions of high and low activity in every task, and that changes between tasks occur in the same way that AM patterns change, with new locations of high and low levels of activity (pp. 116–117).' In other words the electrical AM activity picked up by the EEG is no mere epiphenomenon but is in reality the basic activity of brains. Furthermore, the brain, in this model, is not a computer driven by its input. Rather the brain continually maintains an AM structure that mediates the hypotheses it creates about the past, present and future states of the world around it, as Richard Gregory has suggested. This is used as the basis for a three-stage process: (1) the emergence and elaboration in our brains of goals concerning future predicted events, towards which we will direct our actions; (2) acting and then receiving the sensory consequences of those actions and constructing their meaning; and, (3) modifying the activity and structure of our brains by learning which guides each succeeding emergent path.

I suggested in 1970 in my book *Brain Mechanisms and Behaviour* that the basic framework of action and behaviour is mediated primarily by the great limbic circuits modulated by cortical influences. Freeman supports this hypothesis. What we perceive and experience of the world we act in is a creation of the nervous system that literally uses a process of virtual reality. Common-sense (or folk psychology), along with many misguided contemporary philosophers, believes that brain activity some-

how gives us direct access to external physical events. This, however, is not the case. As Freeman puts it: 'All that brains can know has been synthesized within themselves, in the form of hypotheses about the world' (p. 93). A significant mismatch between the sensory inflow and the model the brain constructs, leads to an alerting response in the animal and a potential pre-programmed change in behaviour.

The linear causal chain suggested by the classical theory of stimulus–analysis–meaning–action is replaced in the neurodynamic theory of a non-causal, non-linear chaotic system in which analysis of the stimulus is coordinated with meaning extraction and action planning in an inextricably interwoven process.

Unlike most neuroscientists Freeman has a sophisticated understanding of the philosophical aspects and metaphysical underpinnings of neuroscience. He pays particular attention to the work of phenomenologists, such as Aquinas, Brentano, Heidegger and Merlau-Ponty, as well as to the work of other scientists, such as Piaget, Baars and Libet, who also take note of these aspects of the problem. The aim of phenomenology, Freeman says, is '… to describe sensory experience without metaphysical pre-occupations' (p. 127), and 'Phenomenology was introduced by European philosophers in the first half of the twentieth century as a systematic attempt to escape from the tradition of introspection' (p. 123). However, it must be noted that the 'tradition of introspection' has recently made a spirited come-back under the influence of neuroscientists such as Richard Gregory and Vilanayur Ramachandran. So, we can now give a scientific account of the contents of consciousness and their properties that adds to the philosophical account (see Smythies, 1999 for details). These additions become important when we consider the nature of consciousness.

Freeman describes consciousness variously (p. 132) as 'both a mental process experienced phenomenologically, and a neural process … that links and enables this sequence of brain states, so it is not just a state variable in the brain', and, in neurodynamic terms, an 'operator that mediates relations between neurons … ' and an order parameter. He adds 'It seems to me that the global AM patterns we detect are the biological basis of awareness … consciousness is the process that makes a sequence of global states of awareness' (p. 141). However, we must also recognize two further important points in our analysis of consciousness.

First, phenomenal consciousness (its contents) has a structure as well as a dynamics. Now that we have realized that the Cartesian distinction between mental events and brain events on the grounds of the property of extension in space (and lack of it) was mistaken, we are free to record the obvious fact that visual and somatic sensations are intrinsically extended in phenomenal space. All visual sensations (veridical as well as hallucinatory) in the visual field in consciousness have certain intrinsic properties – shape, colour, movement – the construction of which are mediated by different brain mechanisms. Following the lead of Paul Schilder (1942) we are also free to recognize that we do not experience any events in the physical body (outside the brain) either. The somatic events that we do experience, as our familiar phenomenal 'bodies', do not constitute the physical body but make up instead what is called in neurology the 'body-image' that depends only on events in the parietal lobe for its existence. At one point Freeman, following Gilbert Ryle, says that the mind–body problem is a pseudo-problem based on a category mistake because it posits a causal relation between an intellect and a material substance. That would indeed be a category mistake. However, the real mind–body problem is not the relation between intellect and a material brain but the relation between an experienced sensation, as a natural existent, and its brain.

Secondly, neuroscientists often waver between saying 'Consciousness is (or is identical with) certain brain events' (which implies the Identity Theory) and 'The biological correlate of consciousness is certain brain events' (which implies some other theory – if A is a correlate of B, then A and B must be different). Freeman is no exception. At one point he says 'Consciousness is a neural process' and at another he says 'global AM patterns are the biological basis of awareness'. I have argued elsewhere (Smythies, 1994) that the formal Identity Theory is impossible and therefore we would be wise to settle for 'correlate' rather than 'is'. An alternative viable theory is the Heisenberg–Bohr theory of mind–brain complementarity (see Smythies

1999). After all, it was Sherlock Holmes who said 'Once you have eliminated the impossible, whatever remains, however improbable, must be the truth'.

Freeman's approach to finding the neural correlate of consciousness is thus fundamentally different from Crick's (1994). The latter suggested that what we should do should be to identify those particular neurons whose activity is uniquely necessary and sufficient for awareness to develop – that operate Crick's famous 'spotlight' of attention – and then see how they differ from other neurons whose activity is not necessary and sufficient for consciousness. In contrast, Freeman claims 'But consciousness is not a spotlight, because that would require a focused beam, whereas global AM patterns are non-local. Moreover, a spotlight requires some other mechanism to aim it, whereas the global AM patterns are self-organizing' (p. 142). In other words, 'awareness' arises out of group neurodynamics involving most of the brain, and there are no unique 'consciousness neurons' as such.

Freeman also presents a penetrating analysis of causality and cogent accounts of the neurodynamic basis of emotion and intentionality, of the fundamental importance of the brain rhythms of the EEG, of the neurodynamic role of the hippocampus, and of the relevance (and irrelevance) of the fashionable topic of synchronization of 40 Hz rhythms.

The concepts of non-linear chaotic neurodynamics are of fundamental importance to all students of the nervous system. They are relevant to our understanding of the workings of the normal brain. They are also being introduced into our study of psychiatric disease, in particular schizophrenia (see Hoffman & McGlashan, 1993). This book gives an excellent introduction to this field, clearly written and presented. I strongly recommend it to all psychiatrists, as well as to all neuroscientists and philosophers.

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The Insider's Guide to Mental Health Resources Online: 1999 Edition. By J. M. Grohol, (Pp. 326; £14.95.) Guilford Press: New York. 1999.

Mental health practitioners can be broadly divided into two groups – those that currently make extensive use of electronic information services, and those who do not. At the moment there is no evidence of any major difference in productivity and effectiveness between these two groups. It seems very likely, however, that this parity is going to change – that as on-line services become more organized and more effectively controlled, the on-line user will be better informed than the practitioner who relies solely on print.

One of the interesting effects of the on-line revolution is that it has drawn attention to the value added by the publication process. By the time a paper is published in *Psychological Medicine* it has been filtered through a complex process of peer reviewing, editing and re-writing. This causes long, irritating, delays but renders the end result more valuable. The fact that the value is largely added by academics, while the revenue goes mainly from public funds (library budgets) to a profit-making corporation is an added complication [Not Cambridge University Press, which is a non-profit charitable entity. Editor]. By comparison, anything can be put on to the web, more or less instantaneously. Water is free if you are willing to suck it up from the Thames. If you want it filtered you either have to pay the water company's rates or filter it yourself.

John Grohol has written a very useful guide to filtering online information in psychiatry and related disciplines. Starting with the basic outlines of e-mail, newsgroups, the web and the use of search engines, he moves on to discuss information sources for psychiatric disorders and diagnostic codes, for locating employment opportunities and educational resources, net-

working, databases, professional associations, publishers and online journals, web-distributed software, and finally, online therapy, leading on to patient education resources. Almost any mental health practioner would benefit from using this book as a guide to useful sources of information.

Aside from an understandable American bias, the main criticism I would make of it is the limited space the book gives to the discussion of patient information services. Mental health practitioners are, in the near future, going to have to get used to dealing with patients who have access to services like the National Electronic Library for Mental Health (see www.psychiatry.ox.ac.uk/cebmh/nelmh for work in progress on this).

Many of the present problems of using on-line services can be illustrated by considering this book itself. In such a rapidly changing field, it is, of course, already becoming slightly dated, and there are many new developments in the pipeline. Updated information is, of course, available on the book's own website at www.insidemh.com, but naturally Guilford Press do not wish to give the book away for free, so you really have to buy the book first, in order to use the updating information effectively. This is a general problem with the web. It is a very useful source of information about information, but when you start to look for the actual information itself you come up against the stumbling block of organizations that, quite reasonably, want to be paid for the value added. Thus, it is clear from their accounts that DSM-IV is a major revenue source for the American Psychiatric Association. Bits of it are freely available online, at, for example, *Dr Bob's Virtual En-Psych-lopedia* at www.ush.bsd.uchicago.edu/dr-bob/tips/dsm4a.html, but not the whole text. Information is a commodity. In fact, it is the commodity. The real information revolution will take place when users come to feel that there is an easy but fraud-proof way of paying very small sums on-line for the particular bits of information they need.

The updating service, as well as the original book, depends on one very enthusiastic individual. If the entire editorial team of *Psychological Medicine* fell under a bus tomorrow, the journal would probably continue with scarcely a hiccup, but the loss of this one individual would leave us with one more semi-derelict site cluttering up the web, among so many others. Providing he manages to keep it going, or establishes an organizational structure to keep it going, I am very happy to recommend this book and its associated web-site to readers of this journal.

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