grammar, taking it to be a refutation of Chomsky's evidence and arguments for an unlearnable, hence inborn, universal grammar).

With this repertoire of concepts, we learn that "[i]f having a feedforward neural architecture is what allows one to discriminate instances of prototypical things, then having a recurrent neural architecture is what provides one with the further capacity to discriminate instances of processes" and that "[w]ithout [the vectorial sequences generated within a well-trained recurrent network]... we would have no concept of temporal extension or of causal processes at all."

This is eliminative materialism at work. Chapter 5 is a grander and grander series of hermeneutic exercises (we are here playing Polonius to Churchland's Hamlet) on the capacity of recurrent nets to recognize the past, understand causality, disambiguate figures and make scientific discoveries. The trouble is that in place of empirical evidence that the actual behavioural capacities of nets can scale all the way up to our own in this way, the few tiny toy demonstrations that exist are instead ratcheted up hermeneutically, by being subjected to a Protean mentalistic interpretation in which recurrent nets turn out to have the seven core properties of consciousness singled out by Churchland: short-term memory, independence of sensory input, steerable attention, alternative interpretation capability, absence in sleep, presence in dreaming and unity of experience. And conscious knowledge turns out to be what passes along 'auto-connected' pathways (directly connected to the information source, as in my knowledge that my own bladder is full) in contrast to 'hetero-connected' pathways (as in my knowledge that *your* bladder is full). (The reason this vocabulary doesn't quite do the eliminative trick for me is that even my hetero-connected knowledge that your bladder is full strikes me as conscious; moreover, the auto-connected thermostat strikes me as being unlikely to be conscious of heat. Ditto for any servosystem or recurrent net.)

It is not that it is impossible that this is what the mind amounts to; it just seems grossly premature to say so on the evidence to date. Most of the mileage seems to be coming instead from our Polonian impressionability and credulity (and I take this to be bad news for the eliminativist programme as a whole, because it shows that we can easily be brainwashed into thinking that the mind–body problem has been solved when it hasn't).

I also think Churchland underestimates the power and purpose of the Turing test, dismissing it as the trivial game to which the Loebner prize (offered for the computer program that can fool judges into thinking it is human) has reduced it, whereas in reality it is an exacting empirical criterion: the candidate model for the mind must have our full behavioural capacities — so fully that it is indistinguishable from any of us, to any of us (not just for one contest night, but for a lifetime). Scaling up to such a model is (or ought to be) the programme of that branch of reverse bioengineering called cognitive science. It is harmless enough to do the hermeneutics after the research has been successfully completed, but self-deluding and question-begging to do it before.

Following her own informative and well written survey of the neurobiological data, Susan Greenfield, in *Journey to the Centers of the Mind*, proceeds straight to the hermeneutics without even pausing over the problem of performance modelling: she offers a consciousness criteria list even shorter than Churchland's, consisting of 'concentric' epicycles — mind patterns of which she espies an abundance nestled in the brain clouds. □

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# Broad perspectives

*Janette Atkinson*

**Visual Development.** By Nigel W. Daw. *Plenum: 1995. Pp. 228. $54, £36.*

THE past 30 years has seen enormous advances in our understanding of visual development and deprivation. Nigel Daw's excellent new book is a celebration of the success of research in this area, and is the first text to unify research results and ideas from behavioural, clinical, anatomical and physiological approaches. This unique feature makes this a book that can be read with benefit by students in psychology, neurobiology, ophthalmology, paediatric neurology and optometry, and its useful glossary makes it accessible even to beginners in the field of visual research. The book also provides a good summary for more advanced researchers likely to have expertise and up-to-date knowledge in some areas but who lack the time to keep up with advances right across the field; it provides a readable, well-illustrated and succinct account to fill the gaps in their knowledge.

Daw begins with a brief historical introduction to clinical problems of visual deprivation, from the seventeenth-century debates of Molyneux and Locke to the work of the Nobel prizewinners David Hubel and Torsten Wiesel, the starting point of the modern research that makes up the bulk of the book. Daw points out that Hubel and Wiesel's work allowed the first clear correlations to be made between clinical observations on strabismus (abnormal alignment of one or both eyes) and deprivation amblyopia (impaired vision with no discernible damage to the eye or optic nerve) and measurable changes in the central visual system.

There then follows a 20-page summary of the functional organization of the visual system, from the retina to cortical streams, which provides the necessary background for an understanding of the three main sections of the book. In the first section, Daw considers normal visual development from three perspectives, psychophysics, anatomy and physiology, and examines the links between them. New techniques and results are succinctly summarized and illustrated around a discussion of which components of development depend on sensory inputs and which are hard-wired — a distinction essential for a proper understanding of the subject of the second section, visual deprivation. Here Daw provides a detailed discussion of the neural correlates of strabismus and amblyopia. He ends this section by addresses the thorny question of human critical periods and differing plasticity in different subsystems, an area of considerable clinical importance for devising sensible medical guidelines for effective intervention and treatment of strabismus and amblyopia. The third section covers more recent research on the mechanisms of plasticity. Daw takes long-term potentiation as a model of the way in which the plastic changes in development may be brought about at the cellular and molecular level, and considers NMDA glutamate receptors to be the prime candidates for mediating early learning.

In a stimulating concluding chapter on future studies and unanswered questions, the author outlines the present controversies and debates, such as the relative roles of excitatory and inhibitory influences in shaping changes in ocular dominance. He also draws attention to the growing field of developmental neurobiology as applied to more complex visual processing. Here there are unanswered questions on the mechanisms controlling the plasticity and development in visuomotor control, spatial cognition, object recognition and integration between analyses in different cortical streams. Let us hope that in a few years, when, hopefully, some of these questions have been answered, someone will cover these areas in a book as clearly written as Daw's.

In the meantime, Daw has given us a lucid and readable exposition, covering in depth and breadth an important era of vision research. □

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