BOOKS & ARTS

Changing our minds

Our environment can affect the way our minds develop, but the relationship is complex.

Brain and Culture: Neurobiology, Ideology, and Social Change
by Bruce E. Wexler
Bradford Books: 2006. 320 pp. $34, £21.95

Paul Bloom

Perhaps the mind begins as a blank slate and we start off, to use Rousseau's phrase, as "perfect idiots". At the other extreme, it could be like a Swiss-army knife, a collection of innately structured neural modules. Perhaps the mind starts off being modular and becomes flexible through development — or perhaps it starts off undifferentiated and becomes modular. Maybe what gives us our uniquely human mental powers is the capacity for complex language. Or cultural learning, Or meta-representation. There is no shortage of one-line theories of human nature.

In his engaging new book, *Brain and Culture*, Bruce Wexler argues that what is interesting about the mind is neither our inborn nature nor the structure of our environment — it is how the two interact. There is, he explains, a principle of internal–external consonance: humans are driven to match their internal neurological structures to the external environment.

In the first half of the book, Wexler discusses the developmental implications of his theory, arguing for a process in which children's neural structures are moulded and transformed by the external environment — it is our nature to be nurtured. Although he concedes that some aspects of human nature might be inborn, his sympathies lie with Rousseau. There is a nicely provocative passage in which he compares the brain and the stomach, suggesting that the stomach is, in some sense, smarter. The stomach can work independently of the environment, whereas the brain cannot: "The brain recreates in itself a representation of environment input which, especially in the formative years, conforms highly to the complexities of that input."

The second half of the book explores the flip side of the consonance principle: once neuroplasticity is reduced in late adolescence, we stop changing our minds to fit the world, and instead try to change the world to fit our minds. We prefer familiar things and people; we reject new ideas; and we become miserable and ill when faced with changing circumstances, as when a loved one dies or when migrating to a new country. There is little neuroscience here; Wexler instead adroitly makes his case by drawing on evidence from fields such as social psychology, history and political science.

Children adapt: a boy learns to communicate with his deaf friend by sign language.

Brain and Culture is a deep, thoughtful and intellectually ambitious book with a high ratio of ideas to pages. It is also gracefully written, very clear and accessible. But the main argument — that there is a consonance principle — is not persuasive.

Consider language. As a staunch believer in the power of the environment, Wexler says that language is a property of cultures, not of brains, and concludes that children who are not exposed to language would never learn to talk. This is a sensible enough prediction, but it seems to be false. Several studies, by Susan Goldin-Meadow, Ann Senghas and others, found that deaf children who are not exposed to a sign language will often create a language themselves. Even in normal language development, children go beyond the input, quickly developing an abstract and generative appreciation of vocabulary and syntax that enables them to produce and understand sentences that they have never before heard.

Elsewhere, Wexler stresses the importance of parents, drawing on the psychoanalytic literature to argue that the social environment of a caregiver plays a powerful role in shaping the child's mind. This is an important point; some nurturing is plainly essential for the normal development of primates, including humans. On the other hand, one of the striking findings of behavioural genetics is that individual differences in intelligence, personality and temperament have little to do with how children are raised. Instead, roughly half the variation is due to genes, and other half to non-shared environment — that is, environmental factors that are independent of how parents treat their children.

Is the consonance principle true of adults? It is easy to find examples where we seek out the familiar and dislike the new, but it is just as easy to find cases that work the other way round. Studies of happiness find that new experiences delight us, but that these experiences lose their effect as they grow familiar. This is why some people are driven to continually seek out novelty, something that happiness scholars have dubbed the 'hedonic treadmill'.

Wexler describes how the death of a loved one usually causes grief and a period of mourning, and interprets this as illustrating the consonance principle at work, as it "vividly reveals the effects of an abrupt disjunction between internal structure and external stimulation, and the time and effort necessary to recreate a comfortable consonance". But a more plausible explanation is that the bereavement is due to a specific sort of disjunction — the loss of someone you love. After all, falling in love is also an abrupt disjunction, but it is often a lot of fun.

Given the range of adaptive problems that humans face (from both an evolutionary and development perspective), there is no reason to expect a single principle that governs interactions between the mind and the environment. In some domains, developmental malleability makes sense; in others, it does not. Sometimes adults should hate the new, when a loved one dies, for example; sometimes we should embrace it, such as when starting a promising relationship. The relationship between the mind and the environment is too complex for a one-line theory. ■

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A turbulent history

Worlds of Flow: A History of Hydrodynamics from the Bernoullis to Prandtl
by Olivier Darrigol
Oxford University Press: 2005. 376 pp. £35, $74.50

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The continuing fascination of hydrodynamics — or its modern, more inclusive offspring fluid dynamics — is due to the fact that many phenomena (such as turbulent flows) that we can observe with our unaided senses pose deep scientific problems that have not been solved to this day. Those unaided observations have led artists and scientists to wonder at the beauty, majesty and waywardness of flows over the centuries. Leonardo da Vinci's pictures of vortices, Hokusai's prints of waves, and the unknown Sanskrit poet's celebration of the splendid diversity of flowing water in current, wave, foam and spray — all these are matched by the scientist's struggle to understand flow and the engineer's attempts to manage it.

The governing equations of hydrodynamics were first written down by the French engineer Claude Louis Navier in 1822. Those equations (with which the name of George Stokes is also associated) remain valid, so the fact that turbulence, for example, has resisted a final solution must be attributed to the inadequacy of our mathematics to handle the strong nonlinearity of the equations and the almost universal tendency of flows to crumple into one form of instability or other except under the mildest conditions. John von Neumann saw the problem clearly when he said that "The impact of an adequate theory of turbulence on certain very important parts of pure mathematics may be even greater" (than on fluid dynamics). The basic mathematical nature of the problem is now being more widely recognized: one of the seven million-dollar 'Millennium Prize' problems identified by the Clay Mathematics Institute in Cambridge, Massachusetts, has to do with Navier–Stokes solutions. Understandably, it is this very inadequacy of the mathematics that has made physical insight, clever experiments and smart approximations such prized virtues in fluid dynamical research.

Until now, anyone interested in the history of this subject has usually had to turn to books such as *History of Hydraulics* (Institute of Hydraulic Research, 1957) by Rouse Hunter and Simon Ince or to John Anderson's *A History of Aerodynamics* (Cambridge University Press, 1997), both strongly oriented to specific engineering disciplines, and a few other rather specialized works. Oliver Darrigol's *Worlds of Flow* is the first book to see hydrodynamics in the wider context of the history of ideas in science. The subject has finally found the distinguished historian it deserves, and the serious history it demands.

Darrigol approaches the subject through the evolution of the concepts that now describe the motion of fluids — viscosity, vorticity, waves, instability, turbulence. He begins with what he calls the small elite of eighteenth-century Swiss and French 'geometers' (including Daniel and Johann Bernoulli), and progresses to the engineers, mathematicians and physicists of the 19th century. During this time, the subject was divided into the ideal world of the hydrodynamicist, who did beautiful mathematics that often failed reality checks, and the real world of the 'hydraulician' who collected useful formulas disconnected from dynamics. These two 'worlds' of flow evolved separately, generally with scorn for each other.

But around the end of the nineteenth century and into the twentieth, many engineers began to examine the foundations of the subject in their own rather pragmatic ways: Osborne Reynolds's studies of turbulent flow, William Rankine's analysis of shock waves and Ludwig Prandtl's many distinctive theories came to characterize an emerging 'engineering

Fluid power: *The Great Wave* by the seventeenth-century Japanese artist Hokusai.