AUTUMN BOOKS

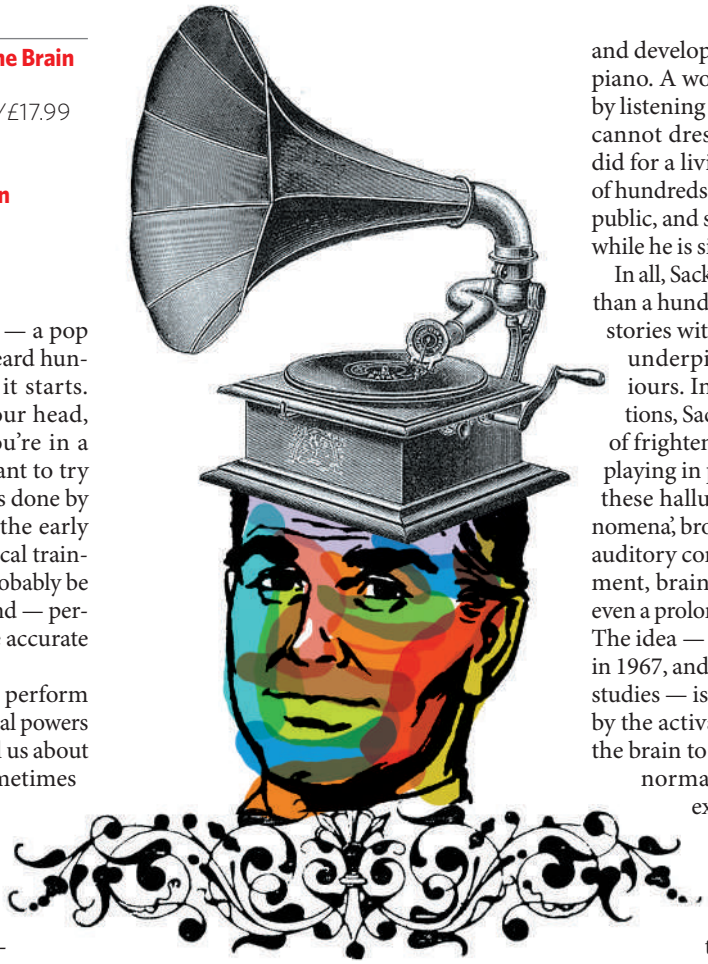
Harmony of the hemispheres

Our brains seem to be finely tuned to music, but of what use are our musical powers and passions?

Musicophilia: Tales of Music and the Brain
by Oliver Sacks
Knopf/Picador: 2007. 400 pp. $26/£17.99

This is Your Brain on Music: Understanding a Human Obsession
by Daniel Levitin
Atlantic: 2007. 320 pp. £17.99

Laura Garwin



ILLUSTRATIONS BY A. MARTIN

Think of a favourite piece of music — a pop song or classical piece that you've heard hundreds of times. Think about how it starts. When you can hear the tune in your head, sing, hum or whistle it (unless you're in a library, in which case you might want to try this later). According to experiments done by Daniel Levitin and Perry Cook in the early 1990s, even if you have had no musical training, your rendition of the tune will probably be very close to the original in tempo, and — perhaps more surprisingly — also quite accurate in absolute pitch.

Why should our brains be able to perform such a feat? Of what use are our musical powers and passions? And what can they tell us about how the brain works, or how — sometimes spectacularly — it doesn't?

Oliver Sacks, continuing in the tradition of *The Man Who Mistook His Wife for a Hat* and *An Anthropologist on Mars*, addresses these questions by offering a collection of 'tales' in *Musicophilia*, illustrating yet more ways in which our brains can take us by surprise. In *This is Your Brain on Music*, Daniel Levitin presents a more systematic account of what cognitive neuroscience has to say about how we process and respond to music. Both authors make the case that music stimulates our nervous systems in unique ways, which account for its special role in our lives, and in those of our ancestors.

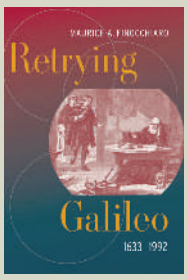
Sacks is the consummate storyteller, and his extensive network of patients, friends and correspondents — supplemented by a magpie-like erudition — keeps him well supplied with raw material. A man is struck by lightning and develops an irresistible desire to play the piano. A woman suffers seizures brought on by listening to Neapolitan songs. A man who cannot dress himself or remember what he did for a living still knows the baritone parts of hundreds of songs, performs successfully in public, and seems to recover his essential 'self' while he is singing.

In all, Sacks recounts the experiences of more than a hundred individuals, interlarding their stories with discussions of the likely neural underpinnings of the described behaviours. In a chapter on musical hallucinations, Sacks tells several hair-raising stories of frighteningly loud, incessant 'jukeboxes' playing in people's brains, and observes that these hallucinations are often 'release phenomena', brought on by a deficit of input to the auditory cortex as a result of hearing impairment, brain damage, the effects of drugs, or even a prolonged period in quiet surroundings. The idea — first suggested by Jerzy Konorski in 1967, and now supported by brain-imaging studies — is that hallucinations are generated by the activation of 'retro' connections from the brain to the sense organs. This process is normally inhibited by the presence of external sensory input.

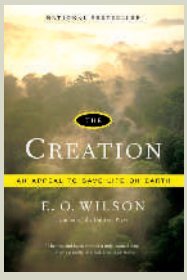
This view of the brain as a dynamic system, finely balanced between inhibition and excitation, returns throughout the book. Musical or other artistic talents, facilitated by activity in the brain's right hemisphere, may suddenly emerge after damage to parts of the left hemisphere that normally suppress right-hemisphere functions, as happens in certain types of dementia. The potential for cross-inhibition between hemispheres — and the ability of regions of the right hemisphere to take over language

NEW IN PAPERBACK

Retrying Galileo, 1633–1992
by Maurice A. Finocchiaro (Univ. California Press, $27.50, £16.95)
The Roman Catholic Church's condemnation of Galileo in 1633 had enormous implications for both science and religion. This book explores the trial, its aftermath and its ramifications up to 1992, when the Pope expressed regret for the Galileo affair.



The Creation: An Appeal to Save Life on Earth
by E. O. Wilson (W. W. Norton, £8.99)
Ecologist E. O. Wilson rallies religious communities to join forces with scientists to save the world from environmental catastrophe, and proposes a drive to document the planet's biodiversity. Simon Conway Morris found the attempt deeply problematic, but conceded: "This clarion call, from one of the world's leading naturalists ... must command respect" (*Nature* **443,** 273; 2006).



functions — also seems to explain why music therapy helps patients who have lost the ability to speak.

Many of Sacks's stories portray the striking independence of different cognitive abilities. We know of people who are tone-deaf; others may be 'rhythm-deaf', or have 'dysharmonia' — the inability to sense the harmonies created by multiple voices or instruments. After suffering brain damage in a car accident, a musician became unable to hear a string quartet as anything but separate voices: "Four thin, sharp laser beams, beaming to four different directions." Perhaps the most distressing syndrome is 'dystimbria', in which musical tones are perceived as unpleasant noises, akin to banging pots and pans or the screeching of a car. Incredibly, Sacks experienced two episodes of temporary dystimbria, during which piano music sounded like "toneless banging with an unpleasant metallic reverberation".

Of course, music speaks to our emotions as well as our intellect, and Sacks presents evidence that the emotional response has its own network in the brain. He also reminds us that music engages our motor circuits (think of foot-tapping and dancing) — a phenomenon that underlies the use of music therapy to 'unlock' patients who have been immobilized by Parkinson's disease.

Sacks's great gift — as a physician as well as a writer — is to see the whole person, rather than just the brain or the disease. He certainly avoids the danger he identifies in his preface: that, as new technologies allow us to examine the brain in ever-greater detail, "the simple art of observation may be lost … clinical description may become perfunctory, and the richness of the human context ignored". Amidst the wealth of wonderful observations and the superabundance of humanity, another danger lurks: that the general reader who was hoping for a clear picture of what we know about the neuroscience of music may come away wanting more.

Help is at hand, in the shape of Levitin's very different but equally enlightening book. Levitin is ideally placed to write about music and the brain, having been a professional musician, sound engineer and record producer before embarking on a career as an academic neuroscientist. He starts with the basics: the physics and neuropsychology of pitch, timbre, rhythm, loudness and harmony. He then discusses the importance of processes such as perceptual completion ('filling in'), feature extraction and feature integration, and describes where they take place in the brain. The comprehensive bibliographic notes provide easy access to the relevant technical literature.

Levitin is just as interested as Sacks in the emotional power of music, but where Sacks tells us of unfortunate individuals who have lost the ability to be moved by music, Levitin offers a mechanistic explanation for its effects. "Music communicates to us emotionally," he says, "through systematic violations of expectations." He also presents evidence for the neural circuit that mediates the emotional response, which involves the cerebellum (the brain region that 'notices' deviations from the expected timing), the mesolimbic system (known to be involved in pleasure, reward and addiction), and the release of dopamine by the nucleus accumbens. A separate circuit involving the auditory cortex looks after our intellectual response, the perception of structure and form.

Can the emotional effect of music really be summed up as the violation of expectations? When I'm listening to something as gut-wrenching as the final movement of Tchaikovsky's sixth symphony, it certainly doesn't feel that way. But Levitin makes a persuasive case that memory, anticipation and surprise are fundamental to our enjoyment of music.

Levitin writes clearly and entertainingly, and has a real flair for analogy. His dual background adds to the fun. In one chapter we find him at lunch with Francis Crick, discussing the cerebellum; in the next, he's at dinner with Joni Mitchell, figuring out why her harmonies sound like no one else's (and why the bass player Jaco Pastorius was essential to her sound).

Both Levitin and Sacks are struck by the ubiquity of music across cultures and times, and by the observation that our brains seem to be, in Sacks's words, "exquisitely tuned for music". They vigorously rebut Steven Pinker's view of music as "useless", with no adaptive value, by asserting its importance in courtship, social cohesion, cognitive development and recall, and in simply making life more bearable. What tipped the balance for me, though, was learning from Sacks that, having no accurate timepieces available, Galileo timed his experiments on the descent of objects by humming tunes to himself. What could be more useful? ■

Laura Garwin is a postgraduate trumpet student at the Royal College of Music in London. She is a former North American editor of *Nature* and former executive director of the Harvard Bauer Center for Genomics Research.

Using maths to tackle cancer

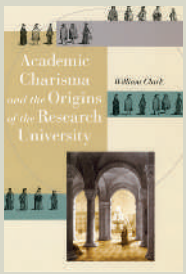
Dynamics of Cancer: Incidence, Inheritance, and Evolution
by Steven A. Frank
Princeton University Press: 2007. 400 pp. $99.50, £59.95

Robert A. Weinberg

Multicellular animals have been around for about 600 million years, and cancer has been a problem for most of this time. There is a risk of cancer whenever the component cells grow and divide, so cancer incidence has increased progressively as the size and lifespan of organisms extended. In a lifetime, humans experience up to 10^{16} mitoses, the process by which a cell duplicates its DNA and divides to make two identical daughter cells. Each mitosis is an invitation to genetic disaster, due to miscopying of DNA, inadvertent breakage of chromosomes, and mishaps in chromosomal segregation. Given these vast opportunities for accumulating mutations, it is surprising that we don't generate numerous life-threatening cancerous cell clones during our first years of life.

The reason for our long and generally cancer-free lives is a series of anticancer defence mechanisms that have co-evolved with our increasing complexity. Most of these defences are wired into the intracellular signalling circuits that govern cell behaviour, although the organization of our tissues and immune systems contributes too. At least five or six of these mechanisms must be breached before a

Academic Charisma and the Origins of the Research University
by William Clark (Univ. Chicago Press, $22.50)
We'd like to think that the modern university developed naturally from the high-minded pursuit of knowledge for its own sake. But William Clark argues that market forces and bureaucracy in eighteenth-century Germany played a large part by creating an environment in which academics achieved success by publishing their results.



Stephen Hawking: A Biography
by Kristine Larsen (Prometheus, $16.95)
Astronomer Kristine Larsen's wide-ranging account provides a fascinating insight into the life and work of one of the past century's most remarkable scientists. She reveals how Stephen Hawking — who recently co-wrote the children's book *George's Secret Key to the Universe* — came to terms with Lou Gehrig's disease and explains the ideas that took cosmology to the top of the bestseller lists.