

bad terrorists almost succeeded in blowing up the world but were prevented from doing so at the last moment by good policemen and other intelligence personnel will be disappointed. Indeed it is one of Levi's strong points that, from beginning to end, he does not engage in any kind of mystery-solving or moralizing. What he does provide is a step-by-step account of the many possibilities of using nuclear bombs and materials for terrorist ends and of at least some of the things that can be done to prevent those possibilities from being realized.

To cut a long story short, Levi sees many serious obstacles standing in the way of would-be nuclear terrorists. They start with the near impossibility of producing (as distinct from purchasing or stealing) high-grade uranium and plutonium; they end with the fact that any nuclear weapon a terrorist may build will almost certainly be crude, very heavy (and thus difficult to conceal and to move) and, quite possibly, unreliable as well. Other possibilities such as a 'dirty' bomb also exist, but compared with a full-scale bomb they are relatively harmless.

That is the good news. The bad news, Levi tells us, is that nuclear terrorism is not impossible in principle. Nor will any set of precautions, however well considered, provide 100% security against it.

Levi's argument may be boiled down to five propositions. First, policy-makers should make "the strongest possible efforts to improve controls over nuclear weapons and materials and prevent their further spread". Second, strategic assessments of the threat should avoid the mistake of concentrating solely on the worst possible scenario. Instead, they should also consider the most likely ones and, to encourage thought and cooperation, as far as possible those assessments should be made public. Third, if nuclear terrorism is to be prevented, it is necessary to set up a global system. The more governments cooperate and the more numerous and varied the obstacles they confront terrorists with, the greater the chances of success. Fourth, even imperfect countermeasures are better than none, because they may well sound the alarm.

Fifth and perhaps most controversial, it is important that thought be devoted, and steps taken to reduce damage from nuclear terrorist

acts after they have taken place — given that, in Levi's view, some such steps should be able to dramatically reduce casualties.

Levi's measured text does not rely heavily on mathematics, and he has hidden the few equations he uses in the appendix. Still, here and there the book, with its flat tone and relatively few verbs, is not altogether easy to understand. Moreover, as he notes, there are certain things that might be useful to terrorists and that, accordingly, he cannot say. These are minor shortcomings if, indeed, they are shortcomings at all. Although the volume will not enjoy a wide readership, for anyone with a serious interest in the possibilities of nuclear terrorism and how to prevent

it, *On Nuclear Terrorism* is a must.

Both authors assume that nuclear proliferation is bad. In Blix's case, this is because it just is so; in Levi's, because it increases the chances of nuclear terrorism. Neither gives a thought to the possibility that proliferation and the balance of terror have actually been excellent things — perhaps the best that ever happened to mankind. The difference between them is that, given Levi's theme, his ignoring this entire question is apt. In the case of Blix, it is certainly not. ■

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How music speaks to us

Music, Language, and the Brain

By Aniruddh D. Patel
Oxford University Press: 2008. 528 pp.
\$59.95

David Poeppel and Erika Bergelson

This book is an intellectual tour de force, raising many more issues than recent popular works by, for example, Oliver Sacks and Daniel Levitin. Not one for the bus, beach or bathtub, *Music, Language, and the Brain* requires focused engagement, but its rewards are rich. Aniruddh Patel offers a thorough analysis of music cognition and its relation to language, and outlines an ambitious and innovative research programme that deepens our understanding of cognition in general.

Music and speech share basic sound elements, and Patel starts by highlighting the similarities and differences between how auditory signals work. The book then delves

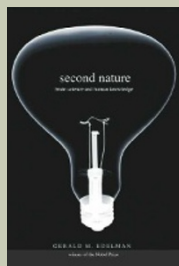
into five topics: rhythm, melody, syntax, meaning and evolution. Each topic is examined within the context of music and language, to see how key cognitive processes overlap or diverge. By evaluating the latest empirical evidence, the author proposes further studies to test or extend previous results — experimentation, he says, is crucial in moving this field forward. Clearly, Patel has particular theories that he favours, but he describes fairly the ideas of others. The book is admirably clear in stating what has been done, and what needs to be done.

The belief that there are fundamental similarities in the processing of music and language is largely intuitive and worth testing. Both have been argued to be unique to humans. The book

Second Nature: Brain Science and Human Knowledge

by Gerald M. Edelman (Yale Univ. Press, \$13, £8.99)

Nobel prizewinner Gerald Edelman offers a new theory of knowledge based on brain science. He shows how advances in neuroscience and physiology have led to a greater understanding of the brain, consciousness and creativity.



Skin: A Natural History

by Nina G. Jablonski (Univ. California Press, £9.95)

Nina Jablonski explores skin's many purposes, such as its role in touch and emotional display, and explains them as the result of billions of years of evolutionary compromise. "Skin is not just about biology, but also the way we live," wrote John Galloway (*Nature* 445, 367-368; 2007).



emphasizes the particulate nature of music and language — both assembled from discrete elements — and suggests that these two domains may share a set of brain structures. By contrast, studies of brain lesion data (from patients with deficits that follow specific brain damage) and brain imaging results are also consistent with a view that music and language processing are, at least in part, segregated.

Patel thinks that there are more general, perhaps computational, links between the two. For example, when discussing rhythm, he proposes that the processing of non-periodic signals is similar in both music and speech. In the section on syntax, he argues that the brain uses similar neural resources to integrate the hierarchical organization of music and language. When discussing evolutionary and developmental similarities, the notion of ‘beat-based rhythm processing’ emerges as a crucial feature that may underlie music and speech.

Patel’s perspective is laudably cross-linguistic and multicultural, citing extensive work from non-Indo-European languages and non-Western-based musical systems. On the website accompanying the book (<http://tinyurl.com/2z2cve>), Patel provides stimulating sound and video examples that clarify the phenomena described in each chapter.

Music, Language, and the Brain is much more than a textbook by one of the field’s most influential practitioners. Each chapter can serve as a stand-alone monograph, and can be read at many levels. There is enough clarity for the general reader to follow the lines of argument, while the specialized reader will discover Patel’s sophisticated and well-researched positions. Ideal for students of music cognition and language, the book outlines numerous experiments and hypotheses — many unusual — that draw together psychology and neurobiology.

If one can criticize anything, it is that Patel’s discussion of the neurobiological foundations of auditory cognition is less nuanced and inspirational than his treatment of behavioural research. That said, we know little about the neuronal bases of complex psychological phenomena. Our understanding of auditory cognition is still mostly informed by behaviourally based psychological research, and in that domain, Patel’s discussion is second to none.

In this definitive analysis of music cognition and its relationship to language, Patel gives us

a work of exceptional scholarship and clarity. Much needed, it elevates the discussion to a level that these exciting areas merit. ■

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Catching a ride on sunshine

Solar Sails: A Novel Approach to Interplanetary Travel

by Giovanni Vulpetti, Les Johnson and Gregory L. Matloff

Springer: 2008. 250 pp. £16.50

Stuart Clark

Conceptually simple and romantic, solar sailing is an enchanting technological solution for space exploration. When a large reflective sail is unfurled in space, photons of sunlight collide with the sail fabric, imparting pressure and causing the sail to move. Such photons are not the electrically charged particles that constantly flow from the Sun to create the solar winds, they are the actual sunlight itself. The angle of the sail to the Sun and its direction of travel determine whether a propelled craft speeds up or slows down, just as a yacht changes course on the sea.

Solar Sails: A Novel Approach to Interplanetary Travel is the latest book to explore this topic, one that has been tackled only a handful of times in the past 20 years. Aimed at undergraduates, the book convincingly captures the history of ideas about solar sails, their current state of play and their future promise.

Moving according to the constant interplay of gravity and the pressure of sunlight, spacecraft pushed by solar sails are highly manoeuvrable. They can skate along unusual interplanetary trajectories that traditional point-and-shoot rocket-propelled craft would find difficult, if not impossible, to navigate. In the flexibility stakes, the only current competition is from the newly tested but expensive ion-drive engine that powers the SMART-1 Moon mapper built by the European Space Agency (ESA) and NASA’s Deep Space One asteroid probe. These propulsion modules run by expelling charged particles, or ions, and can operate using less

fuel than standard chemical engines; however, they are technologically trickier and thus expensive to build.

The idea that sunlight exerts pressure has been around for more than a century, since physicist James Clerk Maxwell proposed it in the 1860s. In the 1970s, metre-long solar sail fins — rather like the fins on a 1950s American car — were attached to the Mariner 10 Mercury space probe to adjust its alignment. Today, some satellites are steered with small sail vanes, a technology patented by the aerospace company EADS Astrium. The extra force of sunlight is a hindrance when fine control of movement is required, as with the next generation of formation-flying spacecraft in ESA’s proposed Darwin interferometry mission to search for life on extrasolar planets. Such vessels must instead be designed to minimize displacements or, at least, to all suffer the forces equally.

Despite the opportunities, solar sails have yet to be used for propulsion in space. The pressure of sunlight is so slight that a vast sail area would be needed to carry a worthwhile payload of instruments through space. Deploying such a sheet presents an equally vast challenge, and has remained the solar sailor’s Achilles’ heel.

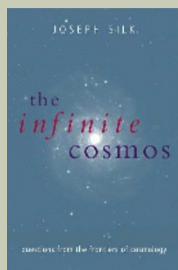
With useful sails being many tens to hundreds of metres long, these mighty structures must be packed into the equivalent of a suitcase for launching and then faultlessly unfurled once in space. If the sail snags, tears or fails to deploy, the mission is over. This risk deters many potential users; according to one project scientist at the ESA: “Why jeopardize your science by relying on an untested technology?”

Scientists and space agencies have, until recently, been resistant to solar sailing. This negative attitude was reinforced by the failure of the Planetary Society’s Cosmos-1 sail, launched atop a converted Russian intercontinental ballistic missile on 21 June 2005 from a submarine in the Barents Sea north of Russia. The upper-stage rocket motor failed,

The Infinite Cosmos: Questions from the Frontiers of Cosmology

by Joseph Silk (Oxford Univ. Press, £9.99)

Summarizing the latest thinking on the Universe and its fate, Joseph Silk muses on the scientific discovery process and the history of ideas about the cosmos. “Black holes, galaxy formation, dark matter, time travel, string theory and the cosmic microwave background all get a mention” (Peter Coles, *Nature* **441**, 285; 2006).



King of Infinite Space: Donald Coxeter, the Man Who Saved Geometry

by Siobhan Roberts (Profile Books, £14.99)

Donald Coxeter helped to bring geometry back into the mainstream at a time when it was unpopular even with mathematicians. Siobhan Roberts’ biography describes his personal and professional life and shows how his impact can be felt in architecture, cosmology, crystallography, immunology and more.

