celebration of individuality". It ends with a warning: "Time could be running out" on our options, and "we may be the last generation of individuals able, or willing, to have them."

Greenfield almost seems, in the course of the book, to have turned into something of a technophobe. In any case, she leaves the reader feeling ambivalent about the wisdom of pushing technology rapidly, relentlessly and often rather thoughtlessly forwards. ■

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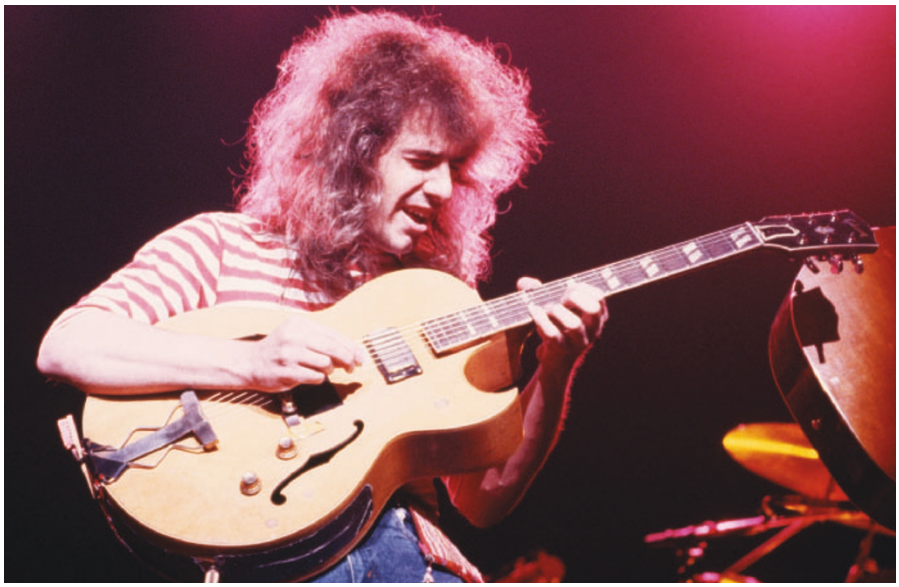

D. A. THOMAS/DAT'S JAZZ/CORBIS

Nice! But what happens to the brain when Pat Metheny hits the right notes?

Jazzing up neuroscience

The Cognitive Neuroscience of Music
edited by Isabelle Peretz & Robert Zatorre
Oxford University Press: 2003. 466 pp. £75, $124.50 (hbk); £34.95, $59.50 (pbk)

Petr Janata

From the soothing lyrical quality of lullabies to the driving pulse of techno, humans render sound patterns in myriad ways to serve diverse purposes. One category of human-generated sound patterns — speech — has the clear purpose of communication and has received considerable scientific attention. But the purpose of another immense range of sound patterns — those that underlie music — is manifold and mysterious. Compared with language, it has been difficult to ascribe to music a dominant role or specific survival value. Perhaps this is why there has been little effort to study the neural processes that underlie it.

The Cognitive Neuroscience of Music, a collection of chapters that originated from a meeting of the New York Academy of Sciences in May 2000, announces the arrival of music at the frontiers of neuroscience. Perhaps unsurprisingly, it begins by addressing allegations that searching for a biological basis for music is futile because music has no apparent adaptive role in human evolution. However, beyond this opening salvo and two chapters explicitly devoted to comparing music and language, the cognitive neuroscience of music is explored on its own merits.

The major strength of this multiauthored volume is that it captures the breadth of the field and introduces a diverse array of behavioural and cognitive neuroscience techniques, providing several perspectives on what music is and how it might be studied. For example, many authors use a bottom-up approach to focus on the neural correlates of the perception and production of individual tones (and their various qualities such as pitch, timbre, loudness and duration), and ultimately on combinations or sequences of tones in various rhythmic patterns. Although they do not necessarily capture the essence of music, such studies of its building blocks are important because they help to identify how musical percepts arise and how they are ultimately differentiated from general multipurpose auditory perception.

Other approaches emphasize the importance of the higher-order structural relationships in music, such as scales, keys and musical phrases, to illustrate that even infants and non-musicians readily internalize such structures when they form memories and images of musical material. Yet other research programmes used expert musicians, with their highly specialized knowledge, in comparative studies of brain anatomy and functional organization, thereby examining an ethologically valid model of brain plasticity in humans.

Unfortunately, the benefits of these multiple viewpoints are diminished by the variation in presentation style. Some chapters, such as those that describe neurological disorders, musical imagery, the processing of expectations in music and language, and the evolutionary basis of music, are written for the lay reader and are a pleasure to read; other chapters have the density of conference proceedings aimed at the specialist. Although the chapters are grouped logically into several themes, the reader is left to stitch the information together across chapters and themes.

The heterogeneity that makes the reading difficult at times is akin to the free improvization of a jazz ensemble before it revisits the recognizable and coherent theme at the head of a piece. Just as a jazz guitarist's improvization follows a coherent path that may be different from the bass player's, the findings from the individual research programmes represented in this book are intriguing and internally consistent, even though their interrelationships may not be obvious. For instance, there is no conceptual framework that reconciles observations of anatomical specificity, or 'modularity', of musical function (arising from neuropsychological assessments of lesion patients) with the variability in the networks that are recruited during musical tasks (as observed in functional neuroimaging experiments).

There has been a doubling in the number of music-related cognitive-neuroscience citations in the Science Citation Index since the conference was held that gave rise to this book. As the themes laid out here are revisited and elaborated on by the numerous players joining in the scientific jam session, the glorious moment will certainly come when all the themes blend into a harmonious whole. ■

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Looking for a new home?

New Worlds in the Cosmos: The Discovery of Exoplanets
by Michel Mayor & Pierre-Yves Frei (transl. Boud Roukema)
Cambridge University Press: 2003. 248 pp. £18.95, $30

Alan Boss

In 1995, Michel Mayor and Didier Queloz presented the first solid evidence for the existence outside our own Solar System of a planetary-mass body orbiting a Sun-like star. The number of likely extrasolar planets has since grown to more than 100, and both

NASA and its European equivalent, ESA, have plans to continue the search from space. Their ultimate goal is the discovery and characterization of Earth-like, habitable planets in orbit around nearby stars. In less than a decade the detection of extrasolar planets has gone from a field without a single credible example to one in which new detections are presented frequently, with a future that seems limitless. Within the next decade we will know how many Earth-like planets there are in the solar neighbourhood, and then we will have some idea about how many of them may support life.

Mayor and Frei present an account of this remarkable transformation that is personal , comprehensive and at all times understandable. They describe not only the recent successes of the field, but also its unfortunate history of failure, despite years of philosophical expectations that planetary systems should exist outside our own. The narrative sometimes slips into the first person as Mayor relates the details of the lifetime of astronomical adventure that led to his magnificent discovery. The book also describes in simple terms the physics behind planetary-system detection, and places it in the context of astronomy.

Detecting extrasolar planets is incredibly difficult, which is why it took until 1995 to find the first, despite the best efforts of many groups around the world. Even today, we have no direct evidence that extrasolar planets exist — we must rely on indirect evidence, primarily the wobble of a star around the centre of mass of a star–planet system, but also the dimming of a star's light as a planet in an edge-on orbit crosses in front of its star.

Nearly all of the detections made to date were achieved by the spectroscopic method, in which the star's wobble results in a periodic Doppler shift of its spectral lines. The wavelength shift is tiny, about one part in ten million at optical wavelengths, where the measurements are made. Arguably the first detection of a planetary system was made, also indirectly, by Alexander Wolszczan in 1992. He used radio-wave observations of a rapidly rotating neutron star to show that its wobble was caused by the presence of several Earth-mass objects. These 'pulsar planets' only whetted the appetites of those who were searching for planets around more benign stars, where life might have a chance to arise.

The goal of determining whether or not any of the Sun's neighbours might have an Earth-like planet in orbit is the dream that drives the field of extrasolar planet research. The discovery by Mayor and Queloz not only helped to launch this search but, along with the claims made for the ALH84001 martian meteorite in 1996, it sparked another new field of endeavour: astrobiology, the study of the origins, evolution, distribution and future of life in the Universe. As a result, astronomers now find themselves in serious discussions with biologists about how an inhabited planet might appear, for example.

New Worlds in the Cosmos is the English-language translation of a French book that was published in 2001. Some of the book's content has been revised, but in such a rapidly changing field as extrasolar-planet detection it is impossible to stay completely up to date. Important news has been made, in terms both of scientific discoveries and of the ambitious space missions planned by ESA and NASA. The possible first discovery of an extrasolar planet by the transit method, OGLE-TR-56, may have been confirmed by follow-up spectroscopy. A planetary-mass object has been found to orbit a distant binary star in the ancient M4 globular cluster, implying that planet formation may have begun within a billion years of the Big Bang, some 13 billion years ago. If that's right, we may well be the late-comers to the galactic party.

All of the extrasolar planets discovered so far seem to be gas giants, similar to Jupiter or Saturn. Nearly all of them are in orbits that are closer to the star than Jupiter is to our Sun, and some are orbiting at Earth's distance from the Sun — prohibiting the existence of an Earth-like planet in a similar orbit. Even 'hot Jupiters' that orbit much closer to the star would have passed through this orbit as they migrated closer, disrupting the formation of habitable worlds at more temperate distances.

In the next few years we can expect to learn how many nearby stars have gas giants in orbits that will allow a habitable Earth-like planet to exist. These stars will be the primary targets for a space telescope planned jointly by NASA and ESA that will be able to detect light from Earth-like planets directly. Through spectroscopy, this could tell us something about what it might be like to live there. Stay tuned for live news coverage, beginning in around 2015. Estate agents, get ready. ■

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Exhibition

Seeing the light

Danish artist Jens Ferdinand Willumsen (1863–1958) is best known for his naturalistic paintings, only rarely turning his attention to scientific portraiture. But his 1913 portrait *En Fysiker*, shown here, is a striking, generic depiction of a young physicist. Seated on a stool, he leans forward, hands gripping his splayed knees, observing an experiment on electric-light rays.

It provides an intensely physical depiction of the researcher's absorption in his investigation of nature. His face and white coat are eerily lit by an incandescent tube, and a ceiling light and a glowing red lamp underneath the laboratory table provide additional light sources. The dramatic composition, the elongated, almost spiritual figure of the physicist, and the colours used all point to the influence of the Spanish artist El Greco on Willumsen's work.

The portrait was commissioned by engineer and industrialist Gustav Adolph Hagemann, who devoted his energy and cash to setting up an electrotechnical laboratory at the Polytechnical Institute in Copenhagen. He supported the 1903 Nobel prizewinner Neils Finsen in his investigations of the use of natural and artificial light in treating skin disease. In accepting the commission, Willumsen, by then a well-established artist, wrote to Hagemann that the picture "should have something to do with science and experimentation as suiting to your spirit". As executed, *En Fysiker* represents the new man of the twentieth century, exploring nature scientifically.

B. RYBERG/J. F. WILLUMSENS MUSEUM

The portrait is included in a display of Willumsen's work in two rooms of the Statens Museum for Kunst in Copenhagen, which houses Denmark's national art collection. It is on loan until summer 2005, while the J. F. Willumsen Museum in Frederikssund is being rebuilt. Until then, it hangs alongside, and contrasts starkly with, *En Bjergbestigerske*, Willumsen's iconic painting of his wife, sculptor Edith Wessel, walking through a mountain landscape and enjoying the natural world without attempting to analyse it. **Colin Martin**