reading'), to relate brain activity to behaviour and to clarify the structure of neural representations. Here, we point out an additional use of MVPA: its ability to interpret overlapping functional activations.

A general issue that arises in fMRI studies concerns the interpretation of overlapping activity from independent contrasts. When a set of voxels is commonly activated by two (or more) contrasts of experimental conditions, two interpretations are possible. In a common-coding interpretation, the shared region is thought to contain neurons that are engaged in a common computational process, which is shared by the two experimental conditions (but not the respective controls). For example, this interpretation has been the favoured account for brain areas that are activated by both observed and performed manual actions [2] and, in this case, has been taken as evidence for 'mirror neuron' [3] systems in the human brain. Alternatively, in a functional-independence interpretation, two overlapping but functionally independent neural populations are thought to be engaged within the common region.

We have recently presented several examples of functional independence in overlapping extrastriate cortical regions using MVPA [4,5]. For example, we found highly overlapping activations in response to motion and human bodies in lateral occipitotemporal cortex. Univariate analysis showed that most voxels in this region were selective for both motion and bodies, which suggests engagement of common neural mechanisms. By contrast, MVPA revealed that the patterns of activation in response to bodies and motion were unrelated, which favours a functional-independence account [5].

Thus, in addition to 'mind reading', MVPA can assess the functional significance of overlap between fMRI activations. This issue is relevant for fMRI studies in all areas of cognitive neuroscience because overlapping activations anywhere in the brain cannot be assumed to reflect shared neural processing. We expect that future experiments that are designed for MVPA should help to support or reject claims about neural mechanisms that are shared across multiple tasks or stimuli.

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Book Reviews

Musical thrills and chills

Sweet Anticipation: Music and the Psychology of Expectation by David Huron, MIT Press, 2006. £25.95/US$40.00 (hbk) (512 pp.) ISBN 0-262-08345-0

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Of all the performing arts, music is the most mysterious. Theatre and dance move us, but mostly through narrative devices. By contrast, music uses only abstract sounds, which are inert in isolation but can, in certain combinations, evoke complex human emotions. Why and how music works its magic on us is the main theme in David Huron's book *Sweet Anticipation*. Huron argues that the emotions we experience when listening to music emerge from the expectancies that are created. He claims that forming expectations is what humans and other animals do to survive; only by predicting the future can we be ready for it. And because the brain ensures that accurate prediction is rewarded, we feel good when we are proved right. The link between prediction and reward causes us to constantly seek out structure and predict how events will unfold. As a temporally evolving texture, music is a super-stimulus for such predictions.

The idea that we form expectancies when we listen to music is not new, but only recently have musical expectations been submitted to intense empirical study. Reaction-time methods show that individuals react to a musical event such as a tone more quickly when the tone is preceded by certain musical events [1]. The generation of expectancies depends on statistical learning. Over the course of our listening history, we internalize the contingencies and relationships that occur most frequently and we build up a library of implicit rules which are brought to bear whenever we hear a piece of music. Modern classical music (e.g. Schoenberg and Stravinsky) might be challenging for Western listeners, more familiar with the music of the classical or romantic periods, because the framework of rules from which it is created are new to them. However, with repeated exposure to this kind of music, listeners can add to their listening library and start to form expectancies from music that was previously alien to them.

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Although statistical learning is the generic mechanism by which we form expectations and ultimately from which we derive pleasure from the listening experience, there is much we have still to learn about how this process occurs. For instance, what unit of musical structure does this statistical learning operate on? Does the brain keep track of how often absolute pitches, intervals or higher-order contingencies occur across a lifetime of musical listening? Huron shows that, with careful experimentation, it is possible to determine which features are most relevant to the representation of music in the brain. He also explains that statistical learning is constrained by 'cognitive firewalls': if the implicit rules that are applied to musical listening were an average of all the regularities that have been internalized throughout an individual's listening history, expectations formed when listening to Beethoven would be similar to those formed when listening to Britney Spears – but they are not. Huron argues that instead we build up parallel families of rules, specific to different musical genres.

Huron's book highlights the extent to which music exists, not in the vibrations of air molecules, but in the patterns we discern from the chaos that reaches our eardrums. And although we might all hear the same music, the structure that each of us perceives is affected considerably by our personal listening histories. A piece of music that is intensely thrilling to one person might leave another cold. Such subjectivity would ring alarm bells for many researchers, but Huron recognizes that any account of how the brain represents music in all its complexity must be able to explain how individual differences arise. Combining his backgrounds in cognitive psychology, musicology and ethnomusicology, Huron shows that the question of how and why music works its magic on us can now be addressed, not only at an abstract or theoretical level, but also with a level of scientific rigour that could not have been anticipated just a few years ago.

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A field of dreams

Inner Presence: Consciousness as a Biological Phenomenon by Antti Revonsuo, MIT Press, 2005. £35.95/US$55.00 (hbk) (440 pp.) ISBN 0-262-18249-1

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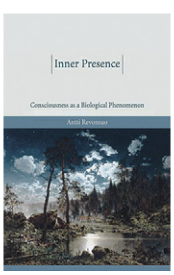

Antti Revonsuo begins his book with the most fundamental question that concerns the study of consciousness: 'why is there something rather than nothing?'. In other words, why do we not walk around, behaving and responding as normal, without experiencing any of it? These questions were originally the reserve of philosophers, but recently scientists from many different fields have tried to answer them. Revonsuo sets out to establish a scientific research program for 'consciousness studies'. Although the book largely concerns his own theory of consciousness, it also reviews current thinking in the philosophical and cognitive sciences about consciousness.

Revonsuo bases his theory on two important foundations. Firstly, he considers consciousness to be a biological phenomenon – consciousness is in the brain. Secondly, he considers someone to be conscious if they experience phenomena. Therefore, dreaming, hallucinations and sleepwalking, for example, are all conscious events, albeit ones that occur in an altered state of consciousness. This would have two main consequences. Firstly, it would mean that motor output and behavior cannot be necessary for consciousness because these are almost entirely absent in dreams. Secondly, when we dream [in rapid-eye-movement (REM) sleep], the retina and other sensory apparatus continue to work, but thalamic and cortical levels of sensory processing are altered [1]. Therefore, Revensuo argues, external stimuli, the sense organs and even the primary sensory cortices are not necessary for consciousness. Instead, the brain simulates its own virtual world; this world is colored, has depth and sounds, and is viewed from an egocentric perspective. It is just like the world we experience when we are awake. It seems that the brain is the finest virtual-reality machine in existence. With these views, which are similar to those expressed in Ref. [1], Revonsuo enters a long-running debate about the role of the thalamus and the primary sensory cortices (particularly V1) in consciousness (e.g. Refs [2,3]), siding with those who believe that V1 is not necessary for consciousness. His argument hangs on the view that dreaming phenomena are like waking phenomena. Certainly *our* dreaming phenomena do not resemble our waking ones; they are more akin to visual imagery. In visual imagery, subjects are asked to imagine an

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