travel into the past and ... future.’ (p. 4) and ‘... allows one...to remember one's own previous ‘thought-about’ experiences, as well as to ‘think about’ one's own possible future experiences.’ p. 9. Autonoetic memory is thus by definition conscious. Tulving believes that memory of this kind could potentially be found in nonverbal animals (and even proposes a test for it), but he is not convinced that it has been demonstrated in animals to date. Tulving nonetheless believes that nonhumans are conscious. Their consciousness, however, is restricted to the eternal present with no awareness of past or future.

None of the other authors who considers episodic memory in this volume agrees with Tulving’s negative conclusion. Menzel (Chapter 8) recounts experiments on symbol-trained chimpanzees which he believes indicate episodic memory. Schwartz (Chapter 9) likewise argues for at least ‘the rudiments of episodic memory’ (p. 237) in apes. Hampton (Chapter 11) presents results of experiments on memory awareness in monkeys and notes that how one views the outcomes of experiments of this type depends on one's definition of consciousness. In a thought-provoking contribution he argues that reflection on the function of conscious awareness may help to shed light on its evolution as well as its present distribution in animal species.

Tulving’s chapter, in pole position and roughly twice the length of the other chapters, combined with the absence of any introductory material from the editors, engenders the expectation that this is to be a book predominantly about tests for episodic memory in animals. It transpires, however, that the remit of the volume is larger than this.

The second most represented issue is metacognition – the awareness of the content of one's own internal states (of which episodic memory is but a special case). Metcalfe and Kober (Chapter 2), Smith (Chapter 10), Hampton (Chapter 11), Son and Kornell (Chapter 12), and Call (Chapter 13) recount experiments in apes, monkeys, and dolphins from a variety of experimental paradigms that indicate an ability to respond on the basis of one's own internal states. Only Son and Kornell clearly recognize that to be aware of one's own mental states does not necessarily imply conscious awareness; to see why not consider a hypothetical example introduced by Hampton (Chapter 11). Hampton invites us to imagine a rabbit, startled by a fox in a field, which, instead of freezing, runs to a shelter it remembers is nearby. Does the overt behavior of running to a shelter prove, not only that the rabbit has a memory of a shelter, but that our rabbit is consciously aware that it has a memory of suitable shelter? Hampton believes so. He offers this parable of the evasive rabbit as evidence that conscious states can have overt behavioral consequences which make them amenable to experimental test even in nonverbal individuals. The problem with his reasoning is that one can accept that the rabbit is in a metacognitive state (it is aware of its memory) without having to assume that this metacognitive state is a conscious one. As Son and Kornell (Chapter 12) lay out – we humans are often in metacognitive states but only a subset of them are conscious.

Son and Kornell suggest several examples of unconscious metacognition. One concerns how contestants in a game show are able to press a buzzer indicating that they know the answer to a question well before they are actually able to retrieve the answers explicitly. In other words the buzzer-pressing is a form of implicit metacognition. Much of our metacognition may not be conscious (are you always consciously aware that you know your own name...?). Consequently metacognition and consciousness are orthogonal concepts. The contributors to this volume produce numerous evidences of metacognition but that does not imply that they have demonstrated consciousness in animals.

Does this mean that the genie should get back in the bottle and experimental study of animal consciousness is impossible? Perhaps. But for as long as even the most jaundiced professor can choose the conscious being when confronted with a choice between a student and a stone we may hold out hope that consciousness is amenable to empirical study. In the meantime the present volume greatly expands our understanding of the things nonhumans can and cannot do.

References
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Brain goes to school


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Since imaging methods have allowed us to take an online look into our brain while it is doing its work, the behavioural and human sciences, including psychology and education, have been facing considerable challenges. The research methods commonly used in these disciplines, such as observing behaviour, conducting interviews, or administering tests and questionnaires appear old-fashioned and awkward when compared with the beautiful colourful pictures that can be produced on the basis of information about electrical activity, oxygen consumption, or glucose metabolism taking place in the brain.

‘Brain-appropriate’ learning?
These insights into the working brain not only satisfy scientific curiosity but also raise solid hopes for schooling and education. Many modern Western countries are not as successful at schooling and education as they should be, given their economic strength and their welfare. Fifteen-year-old students who have been attending school for more than eight years but still reach only low levels of literacy are sadly not exceptional cases. Western countries owe their high technical standards to science and mathematics, but nonetheless only a minority of their students at secondary school and even university level approach a deeper understanding of advanced mathematical and scientific concepts. In this situation many hopes have been directed towards neuroscience. For instance, increasing insight into the developing brain raises the question of whether educational outcomes are unsatisfactory because students have not received appropriate cognitive stimulation during critical periods of brain development. All over the world so-called ‘hothousing’ programs have been emerging in kindergartens, promising that sophisticated brain stimulation methods in the first years of life will better prepare our youngsters for the mental challenges awaiting them at school than their older siblings have been.

These and many other widespread myths [1] about ‘brain-appropriate’ learning are corrected in this clearly written book by Blakemore and Frith, and therefore, researchers involved in human cognitive development and education will particularly appreciate it. Many representatives of this group have become increasingly concerned about the enthusiasm with which some teachers and politicians rely on progress in neuroscientific brain research when it comes to educational reforms, rather than deriving knowledge from cognitive and behavioural development research, classroom practice, and educational engineering [2]. The authors succeed very well in presenting the neurobiological foundations of brain functioning and relating them to important human competencies, such as language-based social interaction, literacy, or mathematical reasoning. At the same time, by explicitly discussing what can be derived from these findings for practical application, they caution readers not to be unrealistic in their expectations.

Studying the challenged brain
Throughout this book, it becomes very clear that the learning brain can only be understood if the content to be learned as well as the environmental context are considered. In the chapters about the literate and the mathematical brain, short introductions to the history of symbol systems are given, showing that human competencies result from the interaction between the capabilities of the brain and developing cultural systems. A major emphasis is put on lifespan trajectories: in chapters on early development, the adolescent brain, and lifelong learning, neurobiological changes of the brain are related to the potential to learn.

The authors manage admirably to integrate and summarize a large number of empirical studies in which methods of behavioural research have been combined with methods of neuroimaging, demonstrating well that the brain images obtained can only be satisfactorily interpreted if information about the mental state and the learning history of the person investigated is available. The wealth of new insights to be gained from the application of neuroimaging methods is always made obvious; the worry of some writers, as reflected in the witty title of the article ‘If neuroimaging is the answer, what is the question?’ [3] does not at all apply to the studies reported here.

The work discussed sheds light on the affordances and constraints of the learning brain. A study of London taxi drivers and studies comparing literate and illiterate individuals demonstrate the fundamental changes the brain can undergo as a result of learning and experience. On the other hand, the numerous studies conducted with people who suffer from dysfunctions such as dyslexia, dyscalculia, attention deficit hyperactivity disorder and autism elucidate the prerequisites in terms of brain development for an individual to be able to take advantage of learning opportunities provided in their environment.

Hopes for educational reform
Although the book is written primarily for laypersons, it also provides stimulating reading for scientists actively engaged in the fields of neuroscience, cognition and developmental research because it prompts them to view familiar content in new perspectives. What this group of readers, however, will miss is a list of references: the names of researchers responsible for the various findings described are mentioned in the text without any additional information. The appendix contains some reading suggestions, the sources of the figures reproduced, and a glossary summarizing the most important terms and research methods, and there is a comprehensive index, which helps readers to quickly find the topics and the scientists they are interested in. However, without a list of detailed references, anyone interested in the original papers will have to search the internet.

The Learning Brain should become compulsory reading for everyone who is involved in educational practice and policy because it by no means raises unrealistic hopes, or – like some other popular books in this field – give more or less trivial advice about ‘brain-appropriate’ learning. It also helps in the understanding of what might have gone
wrong in the brains of learners who, for example, have persistent reading difficulties despite schooling, or who fail to grasp advanced mathematical and scientific concepts. The authors, however, make abundantly clear that it is not merely neuroscience to which we should turn for the competences and the responsibilities needed for improving learning environments and schooling.

References
