be measurable by recording EEG or fMRI signals. It could also be tested whether disrupting the feedforward activation, using TMS pulses delivered at 30–50 ms latency, would abolish the blindsight capabilities. TMS-induced blindsight therefore offers us new opportunities to study the role of the dynamics of visual processing in conscious and unconscious vision, at the same time yielding a better understanding of the blindsight phenomenon in patients.

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Letter

A module for syntactic processing in music?

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Music and language have rules governing the structural organization of events. By analogy to language, these rules are referred to as the 'syntactic rules' of music. Does this analogy imply that the brain actually performs syntactic computations on musical structures, similar to those for language and based on a specialized module [1–3]? In contrast to linguistic syntax, which involves abstract computation between words, rules governing musical syntax are rooted in psychoacoustic properties of sound: syntactically related events are related on a sensory level and involve only weak acoustical deviance. For example, the dominant and tonic chords (referred to as V and I in Figure I, Box 1 of [1]), whose succession forms the most fundamental syntactic unit of Western tonal music, have pitch commonality values [4] two times higher than less related dominant and supertonic chords (V and II).

Musical syntax and sound properties are so strongly entwined that psychoacoustic and cognitive approaches provide highly correlated accounts of Western musical structures [4–6], the former providing a parsimonious account. Long-standing evidence for syntax-like processing in music has been challenged by psychoacoustic approaches: a short-term memory model, operating on echoic images of periodicity pitch, can account for the musical functions of tones in tonal contexts [5]. Does a more abstract computation occur beyond this sensory processing? Some studies provide evidence that cognitive components linked to musical syntax processing can overrule sensory components in music processing [7,8]. However, even these studies acknowledge the predominance of sensory factors during early processing stages.

A key issue is therefore to evaluate whether the contribution of syntactic processing in music is minor (if present at all), as suggested by psychoacoustic approaches, or whether it is as essential as linguistic syntactic processing is for understanding language. Moreover, to conclude in favour of a syntactic module, neuroscientific studies should manipulate orthogonally syntactic and acoustical deviances in musical stimuli, and should confirm that both manipulations result in distinct neural signatures. The findings available in the literature demonstrate neural correlates responding to a combination of musical and acoustic irregularities, but do not provide sufficient evidence for us to conclude that the effects elicited by these irregularities reflect purely syntactic processing. The article by Koelsch and Siebel [1] points to very promising issues but asserting the existence of a module of musical syntax processing is premature.

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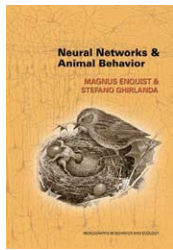
Book Review

Can neural nets capture animal behaviour?

Neural Networks and Animal Behavior by Magnus Enquist and Stefano Ghirlanda. Princeton University Press, 2005. $39.95/£26.95 (pbk) (256 pp.) ISBN 0-691-09633-3

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The power of neural nets is that they can bring together data in ways that are comparable to those forms of multivariate statistics that extract patterns from seemingly confusing data. The nets can learn from experience by changing the weightings on the connections in the net. In this way they can make predictions about the performance of complex systems such as stock markets – so long as the past is a good guide to the future. If they work, it doesn't matter whether or not such neural nets bear any relationship to real nervous systems. Even so, just because what they do seem so clever and life-like, they have excited the hope that they would provide aids to understanding the brain. It soon became obvious that, if they were to be of any use in biology and psychology, their rules of operation must be plausible at both the behavioural and the neural levels. Understandably, neural nets were taken up with especial enthusiasm by those interested in learning in its various forms. The authors of this new book would like to extend the use of neural nets to all aspects of animal behaviour (although presumably not to the behaviour of protozoa and other organisms that do not have nervous systems). For example, they argue for the use of neural nets in understanding evolutionary questions even though one of the main attractions of neural nets is their ontogenetic plasticity. On the face of it, claiming that neural nets can be used to explain phylogeny seems implausible. Undoubtedly small changes in the characteristics of a net can lead to big changes in behaviour (or big changes can still leave its performance robust). However, in those respects, neural nets are no different from many other dynamical systems.

Even though I sympathise with many of the authors' objectives, I do not think that Enquist and Ghirlanda mount particularly cogent arguments for generalising the use of neural nets across the board to all the questions that excite behavioural biologists. Also their book suffers because they are too inclined to give references to other writers without clarifying the nature of these writers' arguments. I suspect that the illustrative figures will mystify the uninitiated and irritate those who know something about neural nets. The authors make claims about the state of the literature that are without foundation. For example, they suggest casually that neural nets have yet to be brought into the animal behaviour literature and that neural nets have not been used to explain developmental phenomena such as sensitive periods. I was disappointed by this claim because I, for one, have spent a lot of time developing neural nets for application in behavioural imprinting [1]. Enquist and Ghirlanda cite this paper but do not address its implications. The overall impression of the book is that the crucial issues about neural nets have not been laid out carefully by the authors and they have not mounted a good enough case for using neural nets in studying all aspects of animal behaviour.

If neural nets are to be useful in understanding some aspects of animal behaviour, they must be used interactively with empirical research. But this raises an immediate problem. The simulations are forced by the programming structure and the computer architecture on which they depend to operate serially rather than in parallel. Therefore, without hardware implementations, the models do not operate in real time and smooth processes are broken up into a series of step-like episodes. This is not a crippling objection but it does mean that setting parameter values from data derived from real biological systems is difficult. Also difficult is simulating an important feature of real animals, namely the rapid interplay between the animal and its environment, the

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