tests, but also in face-processing, gaze monitoring and joint attention [3,8]. Failures in low-level inputs to ToM computations could account for their deficits on these tests. Without co-morbid intellectual disability, individuals with autism seem to have intact capacities for metarepresentation and recursion, as indexed by false-photograph tests and mathematical ability [4,9]. All known cases of patients with ToM deficits arising from brain lesions involve deficits in either low-level social input systems *or* higher-level domain-general abilities. Orbitofrontal patients with deficits on ToM tasks have lower-level social deficits in face-processing and tracking intentions [5]. As Apperly *et al.* detail, medial frontal and temporoparietal junction (TPJ) patients have either executive function deficits, general metarepresentational deficits, or no ToM deficits [1].

When Baron-Cohen, Leslie and Frith published their original paper 'Does the autistic child have a theory of mind?', they argued that ToM is '*one* of the manifestations of a basic metarepresentational capacity' ([10], p. 37; emphasis added). We think it is time to recapture the insights of their original proposal, and abandon the quest for the neural substrate of the fabled ToM module. Apperly *et al.*'s analysis of TPJ patients' performance shows that it might be more promising to focus on the domain-general and uniquely human ability of metarepresentation.

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Evidence for infants' understanding of false beliefs should not be dismissed

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In their response to Leslie [1], Ruffman and Perner (R&P) reiterate their position that there is no need to explain Onishi and Baillargeon's (O&B) recent findings [2] with 15-month-olds in terms of attributing false beliefs (FB). Here we put forward three reasons why their points do not explain the infants' performance.

(1) We are not surprised that Leslie [3] did not respond to Perner and Ruffman's 'neurological' argument [4], according to which 'cells in the brain code for configurations of persons relating to objects'. To support their argument, they cited: (i) a neural-network model [5], which *hypothesized* rather than demonstrated the forming of associations in the prefrontal cortex between two rather than three stimulus features; and (ii) a neurophysiological study [6] showing that cells in the rat's hippocampal region are activated differently for novel and familiar arrangements of pictures, without demonstrating that those cells coded for *episodes* rather than familiarity of arrangements *per se*. Although these studies suggest that brains could form such associations, to present them as evidence for 15-month-olds forming the particular episodic three-way associations that Perner and Ruffman's account requires is unconvincing.

(2) Although we certainly agree with R&P that teleological understanding [7] could account for many examples of early competence demonstrated in infants, this is in fact a red herring in this debate. The teleological model can only take into account actual states of reality, and is therefore unable to explain O&B's result. In fact, Gergely and Csibra [7] explicitly stated that as soon as the teleological interpretation is applied to fictional states (as required by this result), it has been upgraded to mentalistic understanding.

(3) R&P ask why infants would not default to answering in terms of reality on O&B's task if, as Leslie suggests, this is what children failing the traditional FB task do. The answer to this question seems straightforward: in the looking version of the FB task [2], infants are not

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responding to any question. R&P argue that as two-year-olds respond correctly to an '*I wonder where…*' prompt in object search situations, they should also respond correctly to that prompt in the FB task, if indeed they have a concept of FB. Although R&P couch the requirements of these two different tasks as equivalent, this is not the case. In the object search task, the correct response to the 'where' question is the *actual* location of the object, whereas in the implict FB task [8] it is the location *without* the object. It is plausible that younger two-year-olds might prematurely interpret a 'where' question as referring to the hidden object, which would result in a correct anticipatory response in the object search task and an incorrect response in the FB task. The main advantage of O&B's paradigm is that it is devoid of these pragmatic difficulties. It is an open question whether two-year-olds, who fail both the explicit and implicit false belief tasks, would pass a similar test that does not involve interpreting or answering adults' questions.

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Book Reviews

The World in My Mind, My Mind in the World: Key Mechanisms of Consciousness in People, Animals and Machines by Igor Aleksander. Imprint Academic, 2005. £17.95 (UK)/$34.90 (US) (196 pp.) ISBN 1 845 40021 6

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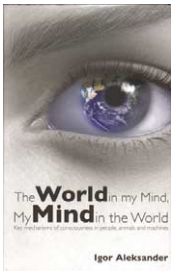

It has become a commonplace for reviews of books on consciousness to ask: Do we really need another book on consciousness? But in reviewing Igor Aleksander's latest book, I can brush this question aside, as there are relatively few books on its particular sub-topic: machine consciousness (other notable exceptions include, e.g. [1,2]). 'Machine consciousness' is perhaps a misleading term – it conjures up clunky robots from 1950s B-movies. The term 'artificial consciousness' might do just as well if not better, and this is particularly so in discussing Aleksander's work. Not only is it concerned with the engineering task of creating artificial systems that either model experience or are themselves truly aware; it is also concerned with the scientific task of illuminating natural consciousness by means of such work, a synthetic component that is often lacking in books on consciousness.

Although Aleksander has been investigating related issues for many years, his work is part of a recent resurgence of interest in machine consciousness, evidence for which can be found in the steady flow meetings on the topic: Cold Spring Harbor (2001), Skövde, Sweden (2001), Memphis (2002), Birmingham, UK (2003), Turin (2003), Antwerp (2004), Hertfordshire (2005) and Lesvos, Greece (2006). More specifically, Aleksander's work is an example of an approach that is currently finding increasing support in the machine consciousness community: the imagination or simulation approach (e.g. [3,4]). On this view, a key aspect of consciousness is the ability of an agent, say a robot, to 'imagine' (represent in a sensory-motor-grounded manner) experiences it is not currently having (e.g. the ability to answer the question 'what would I see if I turned my camera this way?'). The robot can then use such expectations, in conjunction with some basic affective system ('bumper sensors being activated is bad') to assist it in deciding what to do next ('I shouldn't reverse, because if I did, my bumper sensors would be activated'). Aleksander's book is not a summary or analysis of the different work being done in this sub-sub-field, nor was it intended to be. But it does set out to do three things that need doing: (1) clarify the approach, giving specific mechanisms when possible; (2) show how the approach can be used to model or explain various features of consciousness; (3) defend the approach against some standard philosophical objections.

A specific form of the first problem that all workers in this field must confront is: What makes this approach different from familiar AI models of mind? Most if not all traditional AI systems are capable of representing hypothetical situations and reason about them in a way that affects action (planning). Clearly the qualifier that

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