

and also explicitly represent the reality: McGrath did not play and Australia did not win.

Counterfactual thinking is held to be largely down to the number of possibilities represented and how they are manipulated in reasoning. This theme has been the basis of Byrne's work in this area for over a decade, and the tale of this book is partly one of the extraordinary productivity and ingenuity of this work. She tells it in a measured, uncluttered style and there is a relentless beauty in the way the evidence mounts up and the pyramid is assembled. The chapters detailing the research (her own and others') each take an aspect of counterfactual thinking ('*If only*' with things that should and should not have happened, links with causal inference, '*Even if*', '*Only if*') and give us some 'clues from reasoning' before developing, in sections headed 'The rational imagination...' an elaborated explanatory account. Along the way, a table builds up incrementally, setting out principles and corollaries (heuristics and constraints, if you like) governing what is imagined. The theme throughout is that reasoning requires imagination, and that the imagination is rational.

But can imagination really be reduced to counterfactual reasoning? Can counterfactual reasoning really be accounted for largely in terms of representing two contingencies instead of one? Is the elegant simplicity of Byrne's account also perhaps its weakness? The first charge on the sheet might be that of circularity: a sentence is counterfactual because it leads to the explicit representation of two cases rather than one, and the representation of two cases makes it a counterfactual. If that were all there was to it, the charge might stick. However, the basic principles are used to generate novel and surprising predictions. For instance, in the chapter on 'semifactual' reasoning ('*Even if McGrath had played, Australia would still have lost*'), it is predicted, and observed, that the unusual 'Not P therefore Q' inference (McGrath did not

play; Australia lost) would be facilitated. Alternative theories give no obvious route to this result.

Another charge is harder to shake off, however. Byrne's mental models theory is extensional: the tokens in the formal representation are unadorned, that is, they are not subject to any shading or grading in themselves. Hence the emphasis on their numbers. However, there must be more to representation than this. In the present account, the same models can lead to different meanings. To address this problem, the model theory has to make room for tags to the tokens, mental footnotes. These are controversial, though, in the absence of a core semantics for specifying and constraining them. For example, with deontic conditionals (e.g. '*If McGrath plays then England should include an extra batsman*'), the possibilities shift from being true or false to allowed or forbidden, but it is hard in the model theory to find principles that reflect this shift, or determine what makes a possibility undesired rather than untrue.

Evans and Over [1] remarked on the lack of attention that reasoning researchers had given to counterfactuals. This seemed a strange comment then and seems more so now, in view of Byrne's new book. They pay much more critical attention to rival theories than she does, and direct intense fire on the mental model theory. However, they also accept that 'understanding and reasoning... is [sic] based on... mental models representing possible states of the world (p. 71).' Reading both books, one is struck by the similarities as well as the differences. Each deals with how people reason about hypothetical possibilities expressed by conditionals. One needs a model theory, the other needs a semantics. If only they would meet...

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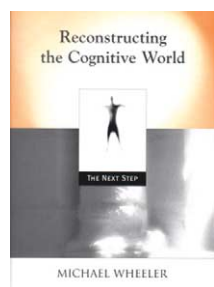
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The next step, or a misstep?

Reconstructing the Cognitive World: The Next Step by Michael Wheeler. MIT Press, 2005. \$35.00/£22.95 (hbk), (340 pp.) ISBN 0-262-23240-5

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Science is full of false turns and missed opportunities. When a new paradigm is rumoured, apologists are apt to go in for intellectual history, in a bid to identify the missteps of their rivals and plot a novel course through the empirical terrain. In his ambitious book, *Reconstructing the Cognitive World*, Michael Wheeler does just that. Wheeler considers afresh the

conceptual foundations of cognitive science, with the aim of carving out a place for what he calls 'embodied-embedded cognitive science' – a rival and successor, he believes, to orthodox computational approaches (both classical and connectionist).

Orthodox cognitive science, argues Wheeler, is committed to a vision of natural intelligence inspired by the work of Descartes. Descartes conceived the intelligent agent as an isolated subject, divided from the world by sensory transducers at one end, effector systems at the other. Such an agent, being out of touch, so to speak, must infer the properties of the world, *representing* them in

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perception. These perceptual mediators function as premises for general purpose reasoning mechanisms, producing judgments that ultimately lead to action. Crucially, claims Wheeler, the actions of a Cartesian agent can only be sensitive to his or her environmental and epistemic context if these too are represented in the reasoning process.

By contrast, the embodied-embedded framework manifests what Wheeler regards as a distinct, Heideggerian vision of cognition and agency. Heidegger submits that in 'smooth coping' – skilful engagement in everyday activities, such as hammering a nail, flying a kite, or making a cup of tea – we don't experience a distinction between ourselves and the tools we use, and that those tools are intelligible to us in a seemingly unmediated way, because they are caught up in 'involvement-networks' (Wheeler's term) of significance relations that provide a context for our actions. The moral is this: smoothly coping agents are not isolated from the world, and therefore have no need to represent objects or contexts of action. As Wheeler sees it, the embodied-embedded framework puts empirical flesh on these philosophical bones. It emphasises, with Heidegger, the primacy of online, time-constrained action, explaining such behaviour in terms of complex causal interactions in an extended brain–body–environment system that is best understood in dynamical-systems (as opposed to computational) terms.

So who's got it right, Heidegger or Descartes? To his credit Wheeler eschews the argumentative strategy of his predecessors (e.g. [1]), that is, a direct assault on orthodox cognitive science on *a priori* or empirical grounds. Kuhn advised [2] that a theory, even one facing a crisis, is never replaced until a genuine rival emerges. Thus, Wheeler reasons, we won't have grounds to abandon work in the orthodox paradigm unless Heideggerian cognitive science can show us how to deal with the crucial problems facing Cartesian psychology.

This brings us to one of the central arguments of the book: that the embodied-embedded framework promises to resolve the frame problem that famously plagues cognitive science – the problem of explaining how intelligent agents rapidly update and access huge stores of knowledge in ways that are sensitive to their needs and goals (see [3]). Wheeler's story is this: Cartesian psychology has something useful to say about offline cognition, for example, wondering about the weather on Mars, planning a murder, or contemplating unicorns, dead aunts, and so on. But it makes the mistake of regarding online and offline intelligence as species of the same genera. Modelling in the embodied-embedded framework avoids Descartes' representation-rich strategy by showing that much of the flexibility and context-sensitivity of online intelligence is a result of 'special-purpose adaptive couplings' and fluid processes of 'continuous reciprocal causation' among brain, body and environment (pp. 275–279). This, of course, leaves the problem of offline intelligence to Descartes. But Wheeler suggests that in the offline domain nature has effectively *failed* to solve the frame problem. Detached reflection by and large 'fails to deliver a

timely result precisely because there are too many possibilities to consider' (p. 281).

Mild astonishment is the appropriate response at this juncture. Although accounting for real-time performance is an important desideratum for any cognitive theory, the frame problem is as much the problem of how we assess the *relevance* of input, whatever the timescale. Witness the ability of the punter to change his bet on hearing that the pollen count is very high today – he rapidly apprehends the significance of this fact given his desire to win, and his belief that the jockey has hay fever. Nature clearly *has* managed to solve the problem of offline context sensitivity. Heideggerian cognitive science won't neutralize the frame problem, nor will it trump Cartesian psychology, unless it can explain how cognitive systems achieve relevant update and retrieval of information in both online and offline contexts. This it demonstrably has not done – a situation that is unlikely to change, Wheeler's enthusiasm notwithstanding. He, like all proponents of embodied-embedded cognitive science, badly underestimates the challenge of providing alternative explanations for the wide range of perceptual and cognitive phenomena already successfully accounted for in computational terms (see, for example, [4]).

For all that, Wheeler's book is a rewarding read, brimming with careful argument and illuminating discussions. Wheeler is at his best in the detailed exegetical work required to establish the Cartesian credentials of orthodox cognitive science, and bring embodied-embedded cognitive science into fruitful contact with Heidegger's phenomenology. He rescues Descartes from the unfortunate focus on dualism that dominates philosophical discussion of his work, arguing convincingly that Descartes was, above all, a science-friendly philosopher who sought to establish a serviceable foundation for the empirical investigation of cognition (see also [5]). And he snatches Heidegger from the clutches of anti-naturalist and anti-realist interpreters. Heidegger, it turns out, held that science is an activity in which 'we succeed in gaining epistemic access to fully objective, agent-independent entities and properties' (p. 152). So although Wheeler fails to make a convincing case for the ascendancy of Heideggerian cognitive science, he clarifies Heidegger's position in important ways, thereby throwing into sharp relief the true strengths and weaknesses of the embodied-embedded framework.

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