think if a human could not tell the difference between the computer's behavior and the behavior of another human. In the standard Turing test, a human subject communicates with both another person and a computer electronically (e.g. by typing on a keyboard). The computer passes the Turing test if the subject cannot tell the computer's communication from the human's – if the computer can 'fool' the subject. We propose that monkeys might be able to serve a role similar to computers in evaluating the 'intelligence' of human players in strategic settings. Imagine two sets of data from experimental studies of some game (e.g. the Ultimatum game or the Prisoner's Dilemma game). One is from pairs of human subjects and the other is from pairs of monkeys. What might be learned if the data are distinguishable, or more interestingly, if they are not?

Conclusion

Although informative, the work of Lee *et al.* generates more questions than answers. We hope that the ones raised above will be addressed. We have raised only a few possible questions. But, as is always the case with research, interesting questions will (at least initially) accumulate as more researchers start to use animals to study issues that have interested experimental economists for many years. Potentially, the results of Lee *et al.* and others following in their footsteps will help us better understand the strategic behavior of humans in interactive environments.

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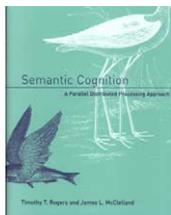8 Dennett, D.C. (1987) *The Intentional Stance*, MIT Press

| Book Reviews

Should we abandon the theory theory?

Semantic Cognition: A Parallel Distributed Processing Approach by Timothy T. Rogers and James L. McClelland. MIT Press, 2004. $50.00 (425 pp.) ISBN 0262182394

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Early in the 20th century, the prevailing view in chemistry and physics, known as energeticism, was that matter was not composed of individual particles, but rather that it consisted of more continuous substances or even flows of energy. According to the philosopher of science Wesley Salmon [1,2], diversity of evidence was crucial for making the case for the particle theory known as atomism. Scientists conducted diverse experiments involving Brownian movement, alpha particle decay, X-ray diffraction, black body radiation, and electrochemistry, all pointing to the existence of atoms and molecules. No one technique, no matter how carefully applied, would have been sufficient to support atomism and lead to the abandonment of energeticism.

The present situation in research on semantic cognition, for example, on conceptual representation and conceptual development, is not exactly parallel. One clear difference is that there is not one single prevailing view. Some accounts, such as exemplar models of categorization [3], have been highly successful but for a somewhat narrow range of phenomena [4]. Bayesian accounts [5–8] have been applied more widely, for example to phenomena in reasoning, categorization and memory. Perhaps the single most prominent view in semantic cognition research is the theory theory [9,10] namely the idea that complex top-down knowledge, particularly in the form of explanations and causal beliefs, shapes and constrains concept learning and use.

Timothy Rogers and James McClelland have published an elegant and encompassing account of how people learn concepts, draw inferences, and carry out other semantic tasks, addressing not only normal adult data but also developmental results and disorders of cognition. For example, the account is applied to studies of hierarchical conceptual knowledge in infants, normal adults, and adults with dementia. It is also applied to experimental results on inductive reasoning and effects of prior knowledge on category learning. Rogers and McClelland's connectionist account is based on a simpler model developed by David Rumelhart in the 1980s.

The most important strength of this book is indeed the diversity of evidence considered. This book sets a high standard for other researchers who want to advance

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theoretical accounts in this area. A related strength is that this book makes conventionally diverse phenomena seem less diverse. For example, results from object manipulation studies on infants and naming studies in adult patients with semantic dementia are explained in terms of a core set of principles, such as error-driven learning and sensitivity to coherent covariation.

Unlike the particle theory in physics, the connectionist account of semantic cognition is probably not developed sufficiently to persuade researchers who favour other views – such as exemplar models, Bayesian accounts, or the theory theory – to abandon their views. As Rogers and McClelland note, the core principles in their model are not unique to the model; accounts such as Bayesian models could embody a parallel set of principles. One area for future development of the connectionist account is to derive and test its distinctive predictions, allowing it to be more clearly distinguished from other views. Some of the chapters, such as the one on category structure in infancy, give detailed descriptions of alternative views, like those rooted in perceptual experience and the theory theory. Yet overall, the authors do not extensively discuss results that rule out other views or for which the connectionist model gives a more accurate account.

The main alternative view running throughout the book is the theory theory. Rogers and McClelland acknowledge similarities between their own account and the theory theory, for example the pervasive role of background knowledge. Perhaps the most crucial difference is that they describe an implemented version of a connectionist model in the book, whereas there is no standardized or implemented version of the theory theory. Hence, some of the success of the theory theory could be a consequence of its abstract nature, which has made it difficult to test. Still, there are limitations of the connectionist view. For example, the book includes considerable discussion of causal reasoning, yet the connectionist model has not yet been applied to a range of detailed results in causal reasoning. So it is too early to favour the connectionist account over the theory theory, which assumes a more extensive role for causal knowledge and reasoning. Also, the connectionist model, as implemented, is mainly concerned with three-place predicates, such as 'dog has legs' or 'maple is-a tree'. It is still unclear whether richer semantic behaviour, involving very complex theories, can be accommodated within this architecture, or if not, what additional architectural assumptions would be needed.

In summary, by traditional criteria of scientific research, namely accounting for a highly diverse set of results using a core set of principles, *Semantic Cognition* makes an interesting and important contribution. Although it is not time for other semantic cognition researchers to abandon their views, this book is deserving of their attention.

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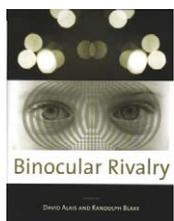10 Gelman, S.A. (2003) The Essential Child: Origins of Essentialism in Everyday Thought, Oxford University Press

When the brain doesn't see eye to eye

Binocular Rivalry edited by David Alais and Randolph Blake. MIT Press, 2004. $65.00/£41.95 (392 pp.) ISBN 0 262 01212 X

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Under normal viewing conditions, the slightly different images projected onto the back of the two eyes fuse to give the perception of depth. When the images falling on corresponding areas of the retina are so different as to be incompatible, binocular rivalry (BR) occurs. This involves a conscious alternation in perception of the two different images, with one dominant and the other suppressed at a given point in time. Because the physical input to the two eyes remains constant, rivalry provides an intriguing case study of how the brain 'makes up its mind' [1] when faced with conflicting information. The new edited book by David Alais and Randolph Blake provides an excellent overview of the current state of research on BR, and places it within its historical context.

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